AIRPORT MISCELLANEOUS LIGHTING VISUAL AIDS

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DEPARTMENT OF TRANSPORTATION
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ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: AIRPORT MISCELLANEOUS LIGHTING VISUAL AIDS

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1. PURPOSE. This advisory circular describes standards for the system design, installation, inspection, testing, and maintenance of airport miscellaneous visual aids; i.e., airport beacons, beacon towers, wind cones, wind tees, and obstruction lights. The publications listed under Appendix 1, Bibliography, provide further guidance and detailed information as required.

2. HOW TO GET THIS CIRCULAR. Obtain additional copies of this Advisory Circular 150/5340-21, Airport Miscellaneous Lighting Visual Aids, from the Department of Transportation, Distribution Unit, TAD-484.3, Washington, D.C. 20590.

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SECTION 1. SCOPE, EXPLANATION, AND MAINTENANCE OF MISCELLANEOUS LIGHTING AIDS

1. Airport rotating beacons conform to Specification CAA-291, or Advisory Circular (AC) 150/5345-12A, Specification for L-801 Beacon. All airport rotating beacons project a beam of light in two directions, 180 degrees apart. For civil land fields only, the optical system consists of one green lens and one clear lens. The rotating mechanism is designed to rotate the beacon at 6 RPM to produce alternate clear and green flashes of light. The main purpose of the beacon is to indicate the location of a lighted airport. Specific information on beacons and the beacon system is found in Section 2 and in Appendix 2, figures 1, 2, and 3.

   a. 36-Inch Rotating Beacon. The 36-inch rotating beacon is the standard large rotating beacon, and is installed at all airports where high intensity lighting systems are used.

   b. 10-Inch Rotating Beacon. The 10-inch rotating beacon is the standard small beacon and is installed at all airports where only medium intensity lighting systems are in use, unless special justification exists requiring the use of a 36-inch beacon at the site. Such a justification would be high background brightness caused by neighboring lights, or where the beacon is used for a navigational aid rather than for location and identification.

   c. Hazard Beacons. Hazard beacons conform to Specification CAA-446 and project a flashing red beam of light, 360 degrees horizontal, from the horizon to the zenith. The main purpose of a hazard beacon is to warn airmen of an obstruction which presents a hazard to air commerce during the hours of darkness and during periods of limited visibility.

2. Beacon Towers. A description of beacon towers is found in Section 3. See Appendix 2, figures 4, 5, 6, and 7.

3. Wind Cone Assemblies.

   a. General. Wind cones are manufactured in two sizes, one for mounting an 8-foot fabric wind cone and one for mounting a 12-foot fabric wind cone, and in three types. Type I is a hinged steel pole support; Type II is an annodized tapered aluminum hinged base support; and, Type III is an "A" frame fixed-base support with a pivoted center pipe support. These wind cone assemblies conform to AC 150/5345-27A, Specification for L-807 Eight-foot and Twelve-foot Unlighted or Externally Lighted Wind Cone Assemblies. Specific information is found in Section 4 and in Appendix 2, figures 8, 9, and 10.

b. Eight-foot wind cone assemblies are installed at all airports unless the use of the 12-foot wind cone assembly can be justified due to special siting conditions. The standard location for these wind cone assemblies is in the center of the segmented circle which gives maximum visibility to pilots in the air and on the ground.

4. Wind Tee. The wind tee conforms to AC 150/5345-36, Specification for L-808 Lighted Wind Tee. Specific information is found in Section 4 and in Appendix 2, figure11. Wind tees are installed in the same area specified in paragraph 3b.

5. Obstruction Light. The obstruction light conforms to AC 150/5345-2. The assembly consists essentially of a red prismatic lens, lamp, socket, and a metal housing fitting. The metal fitting for the single obstruction light consists of a metal body housing, gasket, and a lens fastening device. The metal fitting is made in two types; one with a bottom entrance hub and one with a side entrance hub for mounting on a 1-inch or 3/4-inch pipe or conduit. A natural or synthetic rubber gasket is provided between the lens and the lens bearing surface of the fitting. The gasket is cemented to the fitting. Double obstruction lights are available which meet the same requirements as specified for the single obstruction light fixture but, in addition, they must be designed so that the wiring channel can be exposed from the top to facilitate pulling wire. Section 5 contains specific information on obstruction lights.

6. General List of Equipment. Airport lighting equipment and material covered by FAA specifications shall have prior approval of the Federal Aviation Administration, Airports Service, Washington, D.C. 20590, and shall be listed in AC 150/5345-1B, Approved Airport Lighting Equipment. All other equipment and materials covered by referenced specifications shall be subjected to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the engineer. Equipment and material is covered by reference number and is listed in Appendix 1, "Bibliography." Where Items L-108, L-110, and P-610 are mentioned, they refer to the lighting installation specifications of AC 150/5370-1A, Standard Specifications for Construction of Airports.

a. Beacons. Section 2 contains details of the beacons.

(1) Rotating beacons conform to Specification CAA-291 and AC 150/5345-12A.

(2) Hazard beacons conform to Specification CAA-446.

b. Wind cone assemblies conform to AC 150/5345-27A. Section 4 contains details of these assemblies.

c. Beacon towers. Section 3 contains a description of these structures.

d. Lighted Wind Tees. Section 4 contains a description of these assemblies.

e. Obstruction Lights. Use an obstruction light conforming to AC 150/5345-2, Specification for L-810 Obstruction Light.

f. Panel boards and breakers conform to Federal Specification W-P-115.

g. Weatherproof cabinets conform to National Electrical Manufacturers Association (NEMA) standards.

h. Wire. Use wire in conduit and underground conforming to AC 150/5345-7A or Federal Specification J-C-30, Type RWH, for rubber insulated fibrous covered wire. Use thermoplastic wire conforming to Federal Specification J-C-30.

i. Magnetic Contactor. Use a standard commercially-available magnetic contactor suitable to supply power for the connected load.

j. Splices. Make splices for wires to conform to Item L-108.

k. Tape. Use plastic electrical tape conforming to the requirements of Item L-108.

l. Primary Cable Connectors. Use primary cable connectors conforming to the requirements of AC 150/5345-26.

m. Duct and Conduit. Use duct and conduit conforming to the requirements of Item L-110.

n. Photoelectric Switch. Use a standard commercially-available photoelectric switch or automatic control switch suitable for aviation service for automatic control of the beacon. See Section 4, paragraph 19a(6).

o. Ground Rods. Use ground rods of copper or copper-clad of the length and diameter as shown on the plans, but in no case shall the length be less than 8-feet or less than 5/8-inch in diameter.

p. Control Cables.

(1) 120-Volt AC Use control cables conforming to AC 150/5345-7A.

(2) 48-Volt DC. Use control cables conforming to Rural Electrification Administration (REA) Bulletin 345-14.

q. Booster Transformer. Use a commercially-available booster transformer, suitable for aviation use, to compensate for voltage drop.

r. Control Panel. Use a control panel conforming to AC 150/5345-3A.

s. Auxiliary Relay Cabinet. Use an auxiliary relay cabinet conforming to AC 150/5345-13.

t. Concrete. Use concrete conforming to Item P-610.

u. Vault Equipment. All distribution transformers, oil switches, cut-outs, and other readily available commercial items of equipment, not covered by FAA specifications, must conform to the ratings and standards of the electrical industry.

v. Ground Clamp. Use a ground clamp similar and equal to the type GR manufactured by Burndy Engineering Company.

w. Cable Markers. Use cable markers conforming to Item L-108.

x. Duct Markers. Use duct markers conforming to Item L-110.

y. Bare Copper Wire (Counterpoise). Use bare copper counterpoise stranded wire conforming to Item L-108.

z. Lightning Rod. Use a lightning rod consisting of a galvanized steel copper, or copper-clad rod with the upper end drawn to a point and of sufficient length to extend from the point of fastening to not less than 6-inches above the top of equipment to be protected.

aa. Down Conductor. Use down conductor cable for lightning protection consisting of No. 8 AWG or larger bare stranded copper wire.

bb. Insulating Transformer. Where required for obstruction light series circuits, use a Type I, 100-watt insulating transformer conforming to AC 150/5345-22.

cc. Transformer Housing. Use a transformer housing conforming to AC 150/5345-6.

dd. Vault. Install and connect all vault equipment, equipment accessories, conduit, cables, wires, busses, grounds, and supports necessary to insure a complete and operable electrical distribution center for the airport lighting systems as specified in the plans. Provide and install, when specified, an emergency power supply and transfer switch. Install and mount equipment in accordance with requirements of the National Electrical Code and local code agency having jurisdiction.

ee. Lamps.

(1) Airport Beacons.

(a) 36-Inch Beacon. Use two 1,200-watt, 120-volt, T-20 bulb, mogul bipost lamps.

(b) 10-Inch Beacon. Use two 620-watt, PS-40P, 120-volt, T-20 bulb, medium bipost lamps.

(c) Hazard Beacon. Use two 620-watt, PS-40 bulb, mogul prefocus base, 120-volt lamps.

(2) Wind Cone Assemblies.

(a) 12-Foot Wind Cone Assembly. Use four PS-30 bulb, 200-watt, 120-volt clear bulb, medium screw base lamps. Other types of lamps may be used which meet the maximum 800-watt requirements for 12-foot units.

(b) 8-Foot Wind Cone Assembly. Use four 150-watt, 120-volt clear bulb, medium screw base lamps. Other types of lamps may be used which meet the maximum 600-watt requirements for 8-foot units.

(3) Wind Tee. Use a 25-watt, 120-volt or 240-volt, A-19 clear bulb, medium screw base lamp per socket.

(4) Obstruction Lights.

(a) Multiple Circuit. Use a clear 100-watt, 107-watt, or 116-watt, 120-volt, C-9 filament, A-21 clear bulb, 2-7/16-inch light center length, 4-7/16-inch maximum overall length, medium screw base lamp.

(b) Series Circuit. Use a 1020 lumen, 6.6 ampere, C-8 filament, A-21 clear bulb, 2-3/4-inch light center length, 5-5/16-inch maximum overall length, medium prefocused lamp.

ff. Paint.

(1) Beacons. No paint is specified for beacons.

(2) Beacon Towers. See Section 3, paragraph 15e for details.

(3) Wind Cones and Wind Tees. See Section 4, paragraph 18c(9) and paragraph 18d(10).

(4) Beacon Platform. See Section 2, paragraph 10a(6).

7. MAINTENANCE. A maintenance program is necessary to insure proper operation and dependable service from the equipment. The lighting visual aids installations may be of the highest order of reliability, but their effectiveness will soon depreciate unless they are properly maintained.

a. Schedule. Establish a periodic inspection and maintenance program. The interval between inspections will depend upon the conditions under which the equipment is used, as well as the number of hours that it operates daily. Visual aid systems can become ineffective for many periods during the year if maintenance is not performed.

b. Proper Maintenance. Proper maintenance consists of a regular schedule of testing, lubricating, cleaning, adjusting, relamping, repairing, and replacing wornout or damaged parts. Dirty equipment contributes greatly to operational failures; therefore, keep all equipment free of dust, sand, surplus grease and oil, and other foreign material. Replace all lamps and broken glassware. Clean the lens and lens reflectors in accordance with manufacturer's recommendations. Weather and location will dictate the regularity and type of cleaning.

c. Cables. Megger all cables with 500-volt megger after installation. Record and retain these megger readings. Take monthly readings and compare these readings with the initial values recorded to determine existing conditions of the systems. The initial megohm resistance value shall not be less than 50 megohms. Take corrective steps promptly when monthly megger readings reveal progressive deterioration or faults.

d. Vaults. Keep the vault clean and uncluttered to prevent dirt from accumulating in control compartments and to allow equipment to be accessible at all times. Mount legible warning signs in conspicuous locations.

e. Relamping. Take extreme care to be sure the voltage normally supplied at the lamp receptacle matches, as closely as possible, the lamp's rated voltage. Operation at higher than rated voltage results in shortened lamp life, and operation at lower than rated voltage causes reduction in light output. Check voltage with a voltmeter at night, while the lamp is in operation and with normal load at the field turned on. The average life of the lamps used in the visual aids specified herein varies from 500 hours to 3000 hours when operated at design voltage. However, some of the lamps start burning out long before their average life, therefore, it is suggested that records be kept of the installation date and the total operating hours of the lamps. This will assist in making inspections at regular intervals and will facilitate the replacement of all lamps of one type after a specified number of hours. When replacing lamps, clean out the fixtures and clean all glassware and reflectors.

SECTION 2. AIRPORT BEACONS

8. Locations. There must be a standard location on all airports for visual indicators and signal devices; therefore, the locations prescribed in the referenced publications shall be used for each of the visual aids listed below.

a. Airport Rotating Beacons. Standards for locating this beacon are contained in AC 170/6850-1. Authorization from the regional office on a case-by-case basis must be obtained to locate beacons on top of a control tower. This beacon is used to clearly indicate the location of an airport.

b. Hazard Beacon. Standards for locating this beacon are contained in AC 70/7460-1. This beacon is used to indicate the location of a hazard, and the landmark characteristics.

9. SYSTEM DESIGN.

a. Rotating Beacon.

(1) Optical System.

(a) 36-Inch Rotating Beacon. The optical system consists of a lens combination in each end of the housing with a single lamp in the center. Each combination consists of an 18-inch inner doublet lens and a 36-inch diameter clear outer lens assembly. The outer lens assembly is made of a one-piece bull's-eye center lens, 20-inches in diameter, surrounded by 12 two-piece, 30-degree sectors. The inner doublet lens is furnished in clear and green colors. The beacon operates on 115-volts, 60 cycles, and the rotating mechanism is designed to rotate the beacon at 6 RPM. Aviation beacon lamps, 1200-watt, 120-volt, T-20 bulb, mogul bipost base, are used with the beacon. Upon failure of the first lamp, a magnetic lamp changer is provided to automatically throw in focus and connect to the power source a spare lamp. A telltale lighting circuit operates an indicating light when the spare lamp has been put into the operating circuit. See Appendix 2, figure 1.

(b) 10-Inch Rotating Beacon. The optical system consists of two semaphore lenses, one clear and one green, mounted on bracket support arms which are adjustable for beam elevation. The lamp used is a 620-watt, 120-volt, T-20, medium bipost. A magnetic lamp changer as described above is provided. See Appendix 2, figure 2.

(c) Hazard Beacon. The optical system consists of four 12-inch diameter cylindrical fresnel lens components of heat resistant clear glass and two red glass color screens. These comprise an individual optical unit for each lamp. Two separate 620-watt, PS-40P bulbs, mogul prefocused base, 120-volts are used in the beacon. When equipped with a flashing mechanism, the beacon produces a total of 12 to 40 flashes per minute. See Appendix 2, figure 3.

(2) Power Supply. Primary power supply for airport rotating beacons is either from existing 120/240-volt power supply or from a separately located distribution transformer. Match, as closely as possible, the primary circuit wire size to the lamp's rated voltage. See Appendix 2, figure 14, for formula to calculate wire size and voltage drop. Where the separation distance between

power supply and the beacon is excessive, booster transformers are recommended to maintain proper voltage at lamp receptacles.

(3) Control Circuits. Airport rotating beacons are designed to employ simple switching circuits to energize and to de-energize the power supply. The control system design problem varies. At a small airport, all control equipment and circuitry is self-contained in the power supply equipment; at a very large airport a complex control system is needed. The two types of control systems utilized are direct control or remote control.

(a) Direct Control. Direct control systems are controlled at the power supply by energizing the branch circuit supplying the power to the airport beacon. Normally, this type of system is used for the control of rotating beacons at small airports and for other miscellaneous associated lighting circuits, where needed. Rotating beacons and other miscellaneous circuits may be controlled directly at small airports where a constant current regulator conforming to AC 150/5345-18 is utilized for the control of medium intensity lighting systems. This regulator includes a panel which has 15-ampere circuit breaker switches. Automatic control of the regulator is obtained through a photoelectric switch with a built-in method of switching from automatic to manual control. See Appendix 2, figure 15 for typical automatic control. See Appendix 2, figure 12 for a typical application of an AC 150/5345-18 regulator control panel with direct control operation.

(b) Remote Control. Remote control systems are controlled from a remote control panel which may be located in the cab of the control tower or at other remote areas, using a control panel conforming to AC 150/5345-3A. This panel contains switches and other devices which control operating relays in the vault from which the power is supplied through the relay contacts to the lighting visual aid. The following control voltages are used for remote control of equipment. See Appendix 2, figure 13.

1 120-Volts AC. Where the distance between the remote control panel and the vault is not great enough to cause an excessive voltage drop in the control leads, use the standard control panel switches to operate the miscellaneous equipment power supply relays directly.

Use No. 12 AWG control cable to connect the control panel to the power components in the vault. Use the formula in Appendix 2, figure 14, to calculate the maximum permissible separation between control point and vault, using the manufacturer's electrical operating circuit.

In many cases, the use of 120-volt, special low-burden auxiliary relays, having the proper coil resistance, may be more advantageous for expanding the existing 120-volt AC control system than redesigning the control system to 48-volt DC.

2 48-Volts DC. Use a low voltage 48-volt DC control system where the distance between the control panel and the vault would cause an excessive voltage drop with a 120-volt AC control system. In this system, sensitive pilot relays are activated by the remote control panel switches which, in turn, control the miscellaneous lighting circuits. A 25 pair, No. 19 AWG telephone cable is used to connect the control panel and the pilot relays. The DC control system is adequate for up to 7,900 foot separation. See Appendix 2, figure 13.

(c) Duct and Conduit System. For underground power supply, install cable runs in ducts or conduits in areas that are to be stabilized or surfaced. Install cable runs to the top of towers in conduit. This will provide ready access for maintenance, modification of circuits, and protection to cables during repairs of surface or stabilized areas. Provide a reasonable number of spare ducts or conduits in each underground bank for maintenance and future expansion of facilities. Avoid routing underground duct or conduit through areas which may have to be excavated. Assure that all duct and conduit dimensions meet national, state, or local electrical codes.

b. Hazard Beacons.

(1) Power Supply. Design the power system for hazard beacons as specified under paragraph 9a(2) for the airport rotating beacon. The rated voltage of the lamp shall correspond to, or be within 3 percent higher than, the average voltage across the lamp during the normal hours of operation. In remote areas where commercial power is not available, the auxiliary power supply shall be as specified on the plans.

(2) Control Circuits. Design the control circuits for hazard beacons as specified under paragraph 9a(3) for the airport rotating beacon. Operation of hazard beacons installed on obstructions of an overall height greater than 150-feet above ground or water shall be controlled by a light sensitive device. Adjust this devise so that the lights will automatically be turned on when the North sky light intensity reaches a level of 35 footcandles, and automatically turned off when the North sky light intensity reaches a level of 58 footcandles; otherwise, the light must burn continuously. Where no special means of control has been recommended, a light sensitive control device or an automatic time control switch may be used in lieu of manual control.

(3) Load Contractor. Where the contacts of the relay in the light sensitive control device, or the timer switch selected for automatic control are not rated to carry the connected lamp load, design the control circuit to include a two-pole load contractor relay with contacts rated for the connected lamp load. See Appendix 2, figure 14.

(4) Flasher Unit. Where required, design the power supply to include a flashing device to flash not more than 40 and not less than 12 flashes per minute.

(5) Design duct and conduit systems as specified in paragraph 9a(3)(c) for airport rotating beacons.

10. INSTALLATION.

a. Rotating Beacons.

(1) Mounting the Beacon. All airport rotating beacons are mounted higher than the surrounding obstructions so that the bottom edge of its light beam, when adjusted correctly, will clear all obstructions. Beacons may be mounted on the roof of hangars or other buildings; on top of control towers, when authorized by FAA regional office; or on wooden power pole towers and metal towers as specified in Section 2, paragraph 8a. Check the mounting for the beacon support legs with the appropriate space and dimensions as shown in Appendix 2, figures 1, 2, and 3.

(2) Hoisting and Securing.

(a) 36-Inch Beacon. Where it is impractical to hoist the assembly in one piece, disassemble the beacon into two parts as follows. Disconnect the lead-in wires from the lamp changer terminal block. These are the three wires which run up the shaft from the base as shown in Appendix 2, figure 1. Remove the four cap screws which secure the drum to the steel plate on the vertical shaft and lift the drum off the base being careful not to chafe the lead-in wires. Hoist the base assembly by means of a sling around the shipping platform. Remove the shipping platform and fasten the beacon assembly's supporting legs to the platform, loosely, allowing freedom of individual motion. Backoff the upper capped nuts on each supporting leg so that no strain will be put on the bed plate and then secure each leg positively to the platform. Hoist the drum by means of slings attached to all four handles on the drum. Set the drum in place on the steel plate and secure the drum to the base assembly with the four cap screws before removing the sling. As a final step, reconnect the three lead-in wires to the lamp changer terminal block.

(b) 10-Inch Beacon. If the platform or tower on which the beacon is to be mounted permits, the beacon shipping mounting platform can be left attached and used for hoisting the complete assembly. If it is not possible, remove the shipping platform and the mounting legs from the base of the beacon and hoist the semi-assemblies proceeding as follows. Scribe a circle on the mounting platform having a radius of 6-1/8 inches. On this circle select a point which will be most convenient for the electrical power feeder wires, then from this point locate two other points on the circumference of the circle 120 degrees apart. At the wiring entrance point drill a hole for a one-inch (1.315 inches) pipe. Now, hoist the beacon mounting legs and securely bolt the flanges to the mounting platform taking particular care to center them on the points of the circle as previously located. The mounting leg with the nipple projecting below the flange must be used at the drilled hole for the wiring entrance. Thread one check nut down over each nipple to within 1/2-inch of the top of the flange. Hoist the beacon to the platform and remove the door and dome assembly. Place the beacon on the mounting legs in such a manner that the pipe

nipples project through the clearance holes in the base of the casting. The clearance holes are made oversized to provide for inaccuracies. Place a washer and a check nut on each mounting leg nipple projecting through the casting, and thread each check nut down to within 1/4 inch of the bosses to hold the beacon in place while leveling.

(c) Hazard Beacon. Installation standards for hazard beacons are found in Federal Aviation Regulation, Part 77, and AC 70/7460-1. Hoist the hazard beacon assembly by means of a sling around the shipping platform proceeding as follows. Scribe a circle on the mounting platform having a radius of 6-5/8 inches. On this circle locate four points 90 degrees apart and drill four 11/16-inch holes. Remove the shipping platform and securely bolt the hazard beacon to the platform using the four 11/16-inch drilled holes.

(3) Leveling. Leveling of each beacon is to be checked in the presence of the engineer and must be to his satisfaction.

(a) 36-Inch Beacon. Level the beacon by adjusting the lower check nuts on each leg support. When level, tighten the three upper capped nuts on each leg support. Use the leveling boss on top of the base bed casting.

(b) 10-Inch Beacon. Manipulate the bottom check nuts on each support leg until the beacon is level and then tighten the upper check nuts on each support leg tightly against the bosses to secure the beacon. Use the level provided on the motor mounting plate. Install the door and dome assembly.

(c) Hazard Beacon. Since the hazard beacon mounting platform is accurately leveled before mounting, a check should be made after the installation to determine that the beacon is level.

(4) Servicing. Before placing the beacon in operation, the contractor is to accomplish the following for each size beacon.

(a) 36-Inch Beacon.

1 Glassware. Clean and polish all glassware, both inside and outside, using a type of cleaner which will not scratch the lens.

2 Interior. Clean the interior of the beacon and check for alignment of parts.

3 Slip Rings. Clean and polish slip rings. Apply a very small amount of vaseline to the slip rings, operate about 1/2-hour, then wipe the surplus off the rings. Remove the brushes and lubricate the chamber of the brush holders.

4 Rotating Mechanism. Grease gears of rotating mechanism where gears are accessible. Check to see if gears mesh properly, and turn the motor shaft by hand to ascertain if action of gear train is free. Check and adjust the clutch tension. The clutch shall not be so tight as to stall the motor when the lamp rotating element is held fast. Fill grease fittings with grease conforming to the manufacturer's or engineer's recommendations.

5 Brushes. Set brushes for free motion on slip rings, and adjust springs to 1 or 2 pounds pressure to provide firm contact.

6 Lamps. Secure lamps properly in the sockets.

(b) 10-Inch Beacon. Before placing the beacon in operation, the contractor is to follow the same procedures above with the exception of the following:

1 Shaft Bearings. The two bearings provided for the main shaft are oil sealed ball bearings. No lubrication shall be required during the life of these bearings.

2 Motor. The motor and reducer assembly used in this beacon may be of either the manufacture of the Bodine Electric Company or the Barber-Colman Company. Adapter plates are furnished with the motor reducer assemblies to make them interchangeable. Use the type oil recommended by the manufacturer to oil the motor.

3 Lenses. Clean the lenses and the dome with alchohol and a soft cloth.

4 Slip Ring and Brushes. Clean and polish slip ring and brushes by wiping with a clean cloth moistened with a solvent specified by the manufacturer.

(c) Hazard Beacon.

1 Glassware. Clean and polish all glassware, both inside and outside, using a type of cleaner which will not scratch the lenses.

2 Lamps. Secure the lamps properly in the sockets.

(5) Beam Adjustment. Adjust the elevation of the beam after the beacon has been mounted and leveled. Make final beam adjustment at night so that the result can be readily observed. Adjust the beam elevation as directed by the engineer or as shown on the plans, except in no case shall the elevation of the beam be less than 2 degrees above the horizontal.

(6) Beacon Mounting Platform. Where a beacon is to be mounted at a location other than a beacon tower, and where a special mounting platform is required, the construction of this mounting platform and any necessary lightning protection equipment shall be in accordance with the details shown on the plans.

(7) Wiring. Make complete above-ground electrical connections in accordance with the wiring diagram furnished with the project plan. Install the underground cable for the power feed from the transformer vault to the beacon site in accordance with Item L-108, and Item L-110. Run all exposed wires in not less than 1/2-inch galvanized rigid conduit. Do not install conduit on top of the beacon platform. Install all conduit to provide for drainage. Secure the conduit to steel towers with "Wraplock" straps, clamps, or approved fasteners, spaced approximately 5-feet apart, and secure conduit on wooden structures with galvanized pipe straps and with galvanized wood screws not less than No. 8 nor less than 1-1/4-inches long. Use at least two fastenings for each 10-foot length of conduit. Unless otherwise specified, connect the telltale relay mechanism in the beacon to energize the tower obstruction light circuit when failure of the beacon service (primary) lamp occurs.

(8) Lightning Protection. Install a lightning rod, down conductor, and at least one ground plate or rod for each beacon tower. Install the lightning rod at the top of the tower with the top of the rod extending not less than 6-inches above the top of the beacon. Fasten the down conductor cable to the surface of the tower legs at 5-foot intervals with suitable bronze fasteners having bronze or noncorrosive metal bolts. Sharp turns or bends

in the down conductor are not permitted. Make all connections of cable to cable, cable to lightning rods, and cable to ground plates or rods with approved type solderless connectors or noncorrosive metal of substantial construction. Securely attach the down conductor to the ground rods or plates placed at least two feet away from the tower foundation. Drive the ground rod into the ground so that the top is at least 6-inches below grade. Firmly attach the down conductor to the ground plate or rod by means of a ground plate or clamp. Embed the plates in the area of permanent moisture. The complete lightning protection installation shall be accomplished to the satisfaction of the engineer. The resistance to ground of any part of the lightning system must not exceed 25 ohms.

(9) Panel and Cabinet. Unless otherwise specified, furnish and install at the top of the beacon tower or mounting platform, a circuit-breaker panel consisting of four 15-ampere breakers mounted in a weatherproof cabinet. This provides separate protection for the circuits to the beacon lamps, motor, obstruction lights, and other equipment. Locate the cabinet on the side of the beacon platform, as directed by the engineer.

(10) Booster Transformer. If shown on the plans or specified in the job specification, install a booster transformer to compensate for voltage drop to the beacon. Install the booster transformer in a suitable weatherproof housing under or on the tower platform or at the base of the tower. Make the installation as indicated in the plans and described in the proposal. If the booster transformer is required for installation in the transformer vault, install as described in Item L-109.

(11) Photoelectric Control. If shown on the plans or specified in job specifications, install an automatic control switch at the location indicated in the plan. Use a standard commercially available photoelectric type switch suitable for aviation service. Install, connect, and adjust the photoelectric switch in accordance with the manufacturer's instructions. See Appendix 2, figure 15. Astronomic time switches may also be used.

b. Obstruction Lights. Unless otherwise specified, install two obstruction lights on opposite corners on top of the beacon tower or mounting platform. Mount these lights on conduit extension to a height of not less than 4-inches above the top of the beacon. A top-mounted obstruction light on the 36-inch beacon may be used in lieu of the two platform-mounted obstruction lights. Connect these lights in series into the telltale circuit with the necessary relay and wiring connections.

11. MAINTENANCE OF AIRPORT BEACONS.

a. 36-Inch Beacon.

(1) Relamping. Remove the reserve lamp from its receptacle and mount it in the operating receptacle to replace the burned out lamp. Mount the new lamp in the reserve receptacle. This procedure assures dependable operation of the lamps. Reset the lamp changer, then trip and reset it several times to make sure it is operating correctly.

(2) Slip-rings and Brushes. Clean the slip-rings and brushes with a cloth moistened with a solvent specified by the manufacturer. If sparking or pitting occurs, smooth rings with 0000 sand-paper. If the slip-rings are deeply pitted, replace or have them turned down. Replace wornout brushes.

(3) Lubrication.

(a) Application. Do not use an excessive amount of grease which may result in its dropping down upon the collecting rings or other components causing trouble.

(b) Vertical Main Shaft. The main shaft is supported by two bearings, a ball, and a roller bearing. One alemite fitting is provided for lubricating both of these bearings. This fitting is located on the side of the shaft turntable. Use a high quality medium grade cup grease and apply sparingly. Under ordinary operation, lubricate once a year.

(c) Motor. Sealed bearings are provided on the motor. No lubrication will be required.

(d) Ring Gear. Apply a small amount of medium grade cup grease to the ring gear.

b. 10-Inch Beacon.

(1) Relamping. Replace lamps in the 10-inch beacon as specified under paragraph 11a(1).

(2) Lubrication.

(a) Application. Use caution when greasing and oilings as specified under paragraph 11a(3).

(b) Vertical Main Shaft Bearings. No lubrication shall ever be required for the main shaft, oil-sealed, bearing.

(c) Motor. Use the type oil recommended by the manufacturer. Oil the motor at intervals of approximately one month.

(d) Slip-rings and Brushes. Keep the slip-rings free from oil and dirt by wiping with a clean cloth moistened with a solvent specified by the manufacturer. Avoid sanding if possible. Sanding produces a raw copper surface which shortens brush life. If absolutely necessary, No. 0000 sandpaper may be used, cut in narrow strips, and held on the slip-rings with one's finger. Never use a screwdriver or other hard instrument. Never use emory cloth. Replace brushes showing excessive wear.

c. Hazard Beacon.

(1) Relamping. When relamping, always replace both lamps. Clean all glassware and clean out the fixture.

(2) Flasher. During the relamping procedure, check the flasher's contacts and the flash rate. Clean out the flasher unit.

(3) Load Contactor. During the relamping procedure, check the contacts and clean out the contactor unit.

(4) Booster Transformer. Check the transformer's input and output voltage to determine that it is functioning correctly.

12. TESTING AND INSPECTION. All tests on equipment shall be made in the presence of the engineer and they must be to his satisfaction. All test equipment shall be furnished by the contractor.

a. Securing Check. Determine that all equipment securing screws and bolts have been tightened.

b. Primary, Secondary, and Control Circuits. Test the primary, secondary, and control circuits for continuity and insulation resistance to ground. Use a 500-volt megger for the insulation resistance test. A circuit insulation resistance to ground of at least 50 megohms is acceptable.

c. Transformer and Feeder Fuses. Check to determine that the primary (high voltage) fuses for transformers and feeders do not exceed 200 percent of the rating of the transformer. Secondary (low voltage) fuses for transformer and feeder shall not exceed 125 percent of the transformer rating.

d. Equipment. Check equipment covered by FAA specification to determine if the manufacturers are approved suppliers. Check the equipment for conformance with specification requirements.

e. Vault Equipment. Test the vault equipment as specified in Item L-109. Include a check to determine that the resistance to ground of any part of the grounding system will not exceed 10 ohms.

f. Cables, Wire, and Splices. Check cables, wiring, and splices to obtain assurance that the installation is in accordance with Item L-108.

g. Beacon Fuses. Check all beacon fuses and circuit breakers to determine if they are of the proper rating.

h. Lamp Voltage. Check the voltage to the beacon lamp to determine that the voltage is within two percent of the rated lamp voltage. A voltage drop of 10 percent will reduce the relative intensity of the lamp to approximately 70 percent and increase the lamp life approximately 400 percent, while a 10 percent voltage increase will increase the relative intensity of the lamp to 138 percent, and beacon lamp life approximately to 30 percent.

i. Beacon Rotation. Check the rotation of the beacon to determine that the rotation is within 6 RPM ± 1/2 RPM.

j. Lamp Changer. Check the lamp changer operation to determine that it will function correctly when the operating lamp burns out. De-energize the beacon circuit and remove the lamp from the operating receptacle. Then energize the beacon circuit and note whether the lamp changer will rotate and place the spare lamp in operation. Also, check to see if the obstruction lights (if installed in the telltale circuit) are energized. De-energize the beacon circuit and reset the lamp changer and replace the removed operating lamp in its receptacle.

k. Lamp Focus and Beam Elevation. Check the beacon light beam to determine if the lamp is in focus and if the beam elevation is correct. If it is found that the lamp focus or the beam elevation is incorrect, follow the procedures specified below in making adjustments.

(1) Focusing. Normally, all beacons received from the factory are properly focused. No focusing shall be attempted in the field unless it is definitely determined the lamp is out of focus. When refocusing is necessary, it shall be accomplished only by qualified personnel and in conformance with the manufacturer's instructions.

(2) Beam Elevation. Final beam elevation check shall be made by flight observation. The beacon shall be observed at various altitudes above some point whose distance from the beacon is known and the altitude of the center of the light beam noted (highest relative intensity signal). The beam elevation shall be corrected so that the center of the beam is at the altitude commonly used by approaching aircraft. Elevation adjustment shall be accomplished as follows.

(a) 36-Inch Beacon. The factory setting of the beacon center is two degrees. This setting is intended for level terrain. When it is necessary to change the elevation setting, the lamp changer shaft is raised to lower the beam and lowered to raise the beam. The lamp changer shaft is calibrated and marked in steps of one degree from minus two degrees to plus five degrees. To adjust the lamp changer shaft, loosen the lamp changer shaft adjustable clamp bolt and move the shaft up or down as desired. When adjustment is completed tighten cap bolt to secure the lamp changer shaft in place.

(b) 10-Inch Beacon. The normal setting of the beam center is six degrees above the horizon. Provisions, however, are made for setting the beam center at any point between zero and 12 degrees above the horizon. When it is necessary to change the beam elevation, manipulate the two elevation screws on each lens assembly until the desired elevation is indicated on the marked quadrant, then lock the screw in place.

l. Duct, Conduit, and Duct and Cable Markers. Check all duct and conduit systems before the installation is completed. Assure that conduits, ducts, and cable and duct markers are installed in accordance with Items L-108 and L-110.

m. Automatic Control. Check the photometric control and/or the astronomic time switch to determine that the "on-off" settings are correct.

n. Load Contactor. Check the load contactor to determine that its contacts are rated for the connected lamp load.

o. Complete System Operation Test. The complete installation shall be tested by continuous operation for not less than 1/2-hour as a completed system prior to acceptance. These tests are to include the functioning of each control (manual, remote, or automatic) not less than 10 times.

p. Flash Rate. Determine that the flash rate is not more than 40 and not less than 12 flashes per minute.

SECTION 3. BEACON TOWERS

13. LOCATION. Advisory Circulars 170/6850-1 and 70-7460-1 contain the standards for locating beacon towers.

14. DESCRIPTION OF TOWERS.

a. Structural steel towers conform to Military Specification, MIL-T-8637, and consist of structural steel parts for the basic tower. (Standard heights are 51, 62, 75, 91, 108, 129, and 152 feet). Each tower is supplied with a telescoping ladder and a mounting platform for a 36-inch beacon, approximately 7-feet square

with rails and grating. The railings are punched to permit mounting of a "T" cabinet on any inner surface. See Appendix 2, figure 4, for typical 51-foot tower installations.

b. Tubular steel towers conform to AC 150/5340-8 and consist of different lengths of outside diameter sections of low alloy, high strength tubular steel sections with 60,000 p.s.i. yield strength, welded together to obtain a basic tower of 51-feet in height when erected. At the top of the tower is a platform (welded) designed to accommodate a 36-inch beacon, and a safety device consisting of a cable, locking clip, and belt combination, which permits a workman to climb the tower and to secure himself in the event of a misstep. See Appendix 2, figure 5.

c. Double Wooden Pole Tower. The class, type, and treatment of poles and wooden material for the L-801 double wooden pole tower shall be as stated in the invitation for bids and must conform to FAA-E-113c. It consists of two wooden poles with a minimum top diameter of 6-inches, 2" x 4" wooden crossarm braces, and a platform composed of 2" x 6" and 2" x 12" wooden boards. See Appendix 2, figure 6.

d. Prefabricated tower structure components shall be similar to or equal to components manufactured by Rohn Manufacturing Company. It consists of two lower sections fabricated in 20-foot lengths with one 11-foot upper section and an 8-foot diameter service platform with rails and caging for mounting a 36-inch beacon, and a steel rung ladder for entrance to the platform. See Appendix 2, figure 7 for a 51-foot tower.

15. INSTALLATION.

a. Clearing and Grading. Clear and level the site on which the beacon tower is to be erected. Remove all trees and brush from the area within a distance of 25-feet from the tower or as called for in job plans. Remove stumps to a depth of 18-inches below finish grade and fill the excavation with dirt and tamp. If a transformer vault or other structure is included as part of the installation, clear the area to a distance of 25-feet from these structures. Level the ground near the tower to permit the operation of mowing machines. Extend the leveling at least 2-feet outside the tower legs. All debris removed from the tower site is to be disposed of by the contractor to the satisfaction of the engineer and in accordance with Federal, state, or local regulations.

b. Excavation and Fill. Carry the excavation for the tower footing to a minimum of 4-inches below the footing depth. Then backfill the excess excavation below the footing depth with gravel or crushed stone and compact to the required level. Install the footing plates and then place a thickness of not less than 18-inches of the same gravel or crushed stone immediately above the footing plates in layers of not over 6-inches. Thoroughly tamp in place each layer above the footing plates. The remainder of the backfill may be of excavated earth placed in layers not to exceed 6-inches. Thoroughly compact each layer by tamping. Where solid rock is encountered, cut the tower anchor posts off at the required length and install the holddown bolts as indicated in the plans with the approval of the engineer. Anchor each tower leg to the rock by means of two 7/8-inch diameter by 3-foot long expansion or split holddown bolts and then grout each bolt into holes drilled into the natural rock with neat portland cement. Except as required for rock foundations, do not cut off or shorten the footing members. If the excavated material is not readily compact when backfilled, the engineer may order the use of concrete or other suitable material. Install the concrete footing for tubular towers in accordance with the manufacturer's recommendations. Do not include in the footing height portions in topsoil layer. See Appendix 2, figures 4 through 7 for beacon towers.

c. Erection. Strictly follow detail erection drawings furnished by the manufacturer during construction. Erect all towers in sections from the ground up unless otherwise specified. In the final assembly, install all bolts and fastenings and plumb, true, square, and level the structure. Take up all nuts to a firm bearing after which the bolts may, if necessary, be cut to proper length to protrude three full threads. Place approved locknuts on each bolt over the regular nut. Insert ladder bolts with the head to the outer face of the tower. Install diagonal, leg, and handrail bolts with nuts on the outer face of the tower, unless otherwise specified. Straighten bent parts before erection without damage to the protective coating. Paint surfaces abraded or bared of protective coating with the proper priming paint as specified in paragraph e below. Install the ladder on the side of the tower adjacent to the driveway or the most accessible approach to the tower. Erect the tubular beacon tower in accordance with manufacturer's recommendations. Locate the safety cables on the side of the tower adjacent to the driveway or the most accessible approach to the tower.

d. Lightning Protection. Install a lightning rod as described in paragraph 10a(8).

e. Painting. Use the color scheme for painting towers as shown in the plan.

(1) Parts to be Painted. Do not treat or prime tower parts (except those parts to be exposed to earth) before erection. Give all tower parts placed below ground level or within 12-inches above ground level two coats of approved bituminous paint. Use skilled painters to apply the paint uniformly and free from sags, holidays, and smears. Sharply define division lines between colors. Give each coat of paint ample time to dry before the next coat of paint is applied. Allow a minimum of 4 days for drying on metal surfaces. Do not paint in cold, damp, foggy, dusty, or frosty atmospheres, or when air temperature is below 40°F., or start painting when the weather forecast indicates such conditions for the day. Clean all surfaces before applying paint to be sure they are dry, free from scale, grease, rust, dust, and dirt. Apply the number of coats of paint in accordance with the following instructions:

(a) Steel Towers, Galvanized. Apply after erection, one primary coat of zinc dust-zinc oxide primer and one body and one finish of white or orange paint (as required by the color scheme).

(b) Steel Towers, not Galvanized. Apply after erection one priming coat of red priming paint and one body and one finish coat of white or orange paint (as required by the color scheme).

(2) Body and Finish Coats. Thin the above specified orange and white ready-mixed paints for the body coats in accordance with the manufacturer's recommendations. Apply the following in the absence of such recommendations:

(a) Body Coats. Add not more than 1/2-pint of turpentine to each gallon of ready-mixed paint for the body coats.

(b) Finish Coats. Use the ready-mixed paint as it comes in the container for finish coats.

16. MAINTENANCE OF BEACON TOWERS.

a. Securing Bolts. Check the tower base securing bolts for tightness and spot check other tower securing bolts during beacon relamping procedures.

b. Grounding System. Check all lightning systems' connections for tightness and check the grounding system to determine that the designed resistance to ground of 25 ohms, is maintained.

c. Paint. Check the condition of the tower paint for peeling, bare spots, and rusting to determine if touchup or repainting is necessary.

17. TESTING AND INSPECTION.

a. Structure. Check the tower to determine that the structure has been erected plumb, true, square, and level.

b. Bolts. Check all securing bolts to determine that they have been tightened to a firm bearing and that approved lock nuts have been placed over each regular nut.

c. Painting. Check to see if all surfaces abraded or bared of protective coating have been painted with the proper priming paint.

d. Lightning Protection. Check the installed lightning protection system to determine that the lightning rod, down conductor, and grounding rod have been installed in accordance with the project plans.

e. Ladder or Safety Cable. Check to see if the ladder or safety cable has been installed on the side of the tower adjacent to the driveway or the most accessible approach to the tower.

SECTION 4. WIND CONES AND WIND TEE ASSEMBLIES

18. LOCATION AND INSTALLATION.

a. Twelve-Foot Wind Cone "A" Frame Assembly. The 12-foot "A" frame assembly consists of an "A" frame and a center pivot pipe support constructed of seamless steel pipe. The "A" frame has angle iron cross members welded at the bottom, below, and above the pivot point and has a braced steel footing welded to each leg. The center pivot pipe support is pivoted at its center to the "A" frame with a 1" x 18" bolt which is secured in place with a nut and lock washer. A cast iron slip fitter, slip fitted for 1-1/2-inch pipe in top and 2-1/2-inch pipe in bottom (with set screws provided in top and bottom) is provided on top of the 2-inch center pivot support to secure the 12-foot wind cone assembly to the center support. There are four steel bars, 12 inches long, extending horizontally through the center pipe support at the lower end for securing a cast concrete or metal counterweight.

A hole is provided at the lower end of the center pipe support for attaching a 12-foot length of No. 10 AWG galvanized coil chain for lowering the center pipe support for maintenance of the wind cone assembly. See Appendix 2, figure 8.

b. Twelve-Foot Wind Cone Assembly. The 12-foot wind cone assembly consists of the following:

(1) Wind Cone. A standard 36-inch diameter, 12-foot long ,fabric wind sock.

(2) Cone Support Frame. A cylindrical assembly of steel strap, hot dipped galvanized, arranged for attachment to the two ball bearing housings. An outer clamping ring is provided for holding fabric cones.

(3) Ball Bearing Assemblies. There are two ball bearing assemblies. Each consists of a heavy duty enclosed ball bearing held between bearing support and bearing cover, and protected by a rain shield on top, with a grease fitting on each bearing for lubrication.

(4) Pipe Support. A main vertical support consisting of a lower 1-1/2-inch double extra-heavy pipe and an upper 1-inch double extra heavy duty pipe. A top fitting junction box with a 1-inch hub cover and gasket is supplied for the 1-inch heavy duty pipe. Four lighting fixture supports, 4-foot lengths of 3/4-inch standard pipe, are attached 90 degrees apart.

(5) Lighting Fixtures. Four, deep-bowl reflector units, with 3/4-inch side hubs, designed to accept a PS-30, 200-watt, 120-volt, clear bulb medium screw base lamp and one standard obstruction light fixture with red prismatic globe designed for 100, 107, or 116 watts, 115, 120, or 125 volts, A-21 clear bulb, medium screw base are supplied.

(6) Counterweight. The counterweight may consist of lead weights which may be furnished with the "A" frame assembly, or it may consist of concrete poured around the bottom of the hinged support. Where concrete is used, it shall be approximately 12X20-inches by 24-inches deep; and shall weigh approximately 500 pounds.

c. Eight-Foot Wind Cone Assembly.

(1) Anodized Aluminum Hinged Base Tapered Pole Wind Cone Assembly. This assembly consists essentially of an anodized aluminum tapered pole with a hinged base shaft assembly with bearing supports, and a tubular aluminum framework with bearings for

support of a fabric wind cone, with provisions for mounting external lighting equipment. See Appendix 2, figure 9.

(2) Hinged Steel Pole Wind Cone Assembly. This assembly consists essentially of a hinged steel pole shaft assembly with bearing supports, fabric cone, metal framework support between the shaft assembly and throat of the fabric cone, lighting fixture assembly for externally illuminating the cone, and an obstruction light. See Appendix 2, figure 10.

(3) Power Supply. Design the power supply system for the wind cone as specified under paragraph 9a(2) for rotating beacons.

(4) Control System. Design the control system for the wind cone as specified under paragraph 9a(3) for rotating beacons.

(5) Duct and Conduit System. Design duct and conduit systems for wind cones as specified in paragraph 9a(3)(c) for rotating beacons.

(6) Electrical Connections. Make all electrical connections in accordance with the wiring diagram furnished with the project plans. Install underground cable (from the transformer vault to the wind cone site) and duct for paved areas in accordance with Items L-108 and L-110.

(7) Booster Transformer. If shown on the plans or specified in job specifications, install a booster transformer in a weatherproof housing to compensate for voltage drop to the lamps. Install the booster transformer as indicated in the plans and described in the proposal. For installation in the transformer vault, install in accordance with Item L-109.

(8) Ground Connection and Ground Rod. Install a ground rod, grounding cable, and ground clamps for the "A" frame of the 12-foot assembly or pipe support of the 8-foot support near the base or hinged base of the 8-foot aluminum support. Use a copper or copper clad ground rod of the diameter and length specified in the plans. Drive the ground rod into the ground adjacent to the concrete foundations so that the top is at least 6-inches below grade. Use No. 8 AWG bare stranded copper wire, or larger, for the grounding cable. Attach the grounding cable firmly to the ground rod by means of a ground connector

or clamp. Securely attach the other end of the grounding cable to a leg of the "A" frame, or the base of the pipe support, with a noncorrosive metal of substantial construction, and to the aluminum hinged base with a noncorrosive metal of substantial construction which will be compatible with aluminum. The resistance to ground shall not exceed 25 ohms.

(9) Painting.

(a) 12-Foot "A" Frame and 8-Foot Hinged Support Wind Cone. Apply three coats of paint (one prime, one body, and one finish) to all exposed material installed under these items except the fabric cone, obstruction light globe, and lamp reflectors. Give the wind cone assembly, if painted on receipt, one finish coat of paint in lieu of the three coats specified. Use paint conforming to Federal Specification TT-P-59. The color conforms to Federal Standard 595, Aviation Gloss Orange No. 12197.

(b) 8-Foot Aluminum Hinged Base Support Wind Cone. No painting is necessary for the aluminum support since all aluminum surfaces are anodized for maximum corrosive protection.

(10) Operation Device and Padlock.

(a) 12-Foot "A" Frame and 8-Foot Hinged Support. Install a suitable operating chain for lowering and raising the hinged top section. Attach the chain to the pole support in a manner to prevent the light assembly from striking the ground in the lowered position.

(b) Aluminum Hinged Base Support. Install a braided nylon cord tag line by knotting into the 3/8-inch diameter eye at the top of the pole for raising and lowering the top section. Store the tag line after installation around the cleat installed at the 3-foot, 6-inch level of the pole.

(c) Securing. Secure the hinged top section of the 8-foot wind cone to the fixed lower section with a padlock. DELIVER THE KEYS FOR THE PADLOCK TO THE ENGINEER.

d. Airport Wind Tee.

(1) Foundation. Construct a concrete foundation having anchor bolts and mounting dimensions as shown on the plans or as shown in Appendix 2, figure 11. Pour the concrete so that it will rest on undisturbed or stabilized soil. Extend the foundation below

the frost line. Reinforce the foundation with steel bars formed and placed as indicated in the plans. The size of the foundation will depend upon the local soil conditions. Smooth the finish concrete surface with a steel trowel or by rubbing to a smooth finish. Caution shall be taken to make sure the top of the concrete foundation is level and that the anchor bolts as well as the conduit is accurately spaced. Care taken at this point will save considerable amount of effort later.

(2) Base. Before fastening the wind tee base to the foundation, recheck the mounting bolts for correct spacing. Do not strain or force out of position the base or legs to fit incorrect spacing of mounting bolts. Mount the wind tee base over the anchor bolts and conduit projecting out of the foundation. Place a level on top of the base to check for levelness and shim if necessary. Secure the base in place. Recheck levelness. The wind tee base must be perfectly level to indicate true wind direction and float freely.

(3) Assembling and Mounting Tee Body. Before bolting the sections of the wind tee body, be sure that the twist-lock plug and receptacle connections are made. Assemble the tee body sections and mount the sections to the base in accordance with manufacturer's installation instructions.

(4) Leveling. After the wind tee has been mounted in place, accurately level and, if necessary, counterbalance in accordance with the manufacturer's instructions. Do not use any substance for counterbalance which will retain moisture or cause corrosion.

(5) Servicing. Before placing the wind tee in operation, the following service checks shall be followed.

(a) Alignment. Clean interior of base and check for alignment of parts.

(b) Cleaning. Clean and polish slip rings. Apply a very small amount of vaseline to the slip rings and wipe off surplus.

(c) Adjustments. Set brushes for free motion on slip rings and adjust springs to proper pressure.

(d) Operation. Check adjustment and operation of control equipment where necessary.

cone assembly -- ... bending horizontally

(6) Wiring. Make complete above ground connections to the power supply cables and to the control cables, if specified, and all internal connections for the operation of the lights and the control of the wind tee. Install underground cable and duct between the transformer vault and the wind tee in accordance with Items L-108 and L-110.

(7) Conduit. Run all exposed wiring or cable in not less than one-inch rigid steel conduit. Install the conduit for the power supply through the concrete pedestal and connect to the base as indicated in the plans. Terminate the underground section of the conduit in a bushing to protect the power supply cable. The underground cable may be installed in the conduit above ground.

(8) Ground Connections and Ground Rods. Unless otherwise specified, install a ground rod, grounding cable, and ground clamps for grounding the wind tee near the bottom of the metal base. Use a copper or copper clad ground rod of the diameter and length specified in the plans. Drive the ground rod into the ground adjacent to the concrete base so that the top is at least 6-inches below grade. Use No. 8 AWG bare stranded copper wire or larger for the ground cable and attach the ground rod firmly to the metal housing under the tee by means of a suitable pressure type grounding lug or clamp of non-corrosive metal and of substantial construction. The resistance to ground is not to exceed 25 ohms.

(9) Booster Transformer. If shown on the plans or specified in the job specifications, install a booster transformer to compensate for voltage drop to lamps. Install the booster transformer in a suitable weatherproof housing as indicated in the plans and described in the proposal. If the booster transformer for the wind tee is required to be installed in the transformer vault, install it in accordance with Item L-109.

(10) Painting. The specifications covering the manufacture of the wind tee and base requires that these items be painted by the manufacturer. However, the wind tee shall be checked for any rusty or bare surfaces which shall be cleaned and painted with one prime and two finish coats to match the original finish. After erection, all other exposed equipment (except the concrete pedestal) shall be given one prime and one finish coat of chrome yellow paint.

e. Lighted Wind Tee. Lighted wind tees conform to AC 150/5345-36. This assembly consists essentially of a metal structure in the shape of a single stroke "T", when viewed from above, complete with a lighting system, supporting shaft and bearings, base housing, and the necessary electrical connections between the lamp and base. The wind tee is a free swinging type. The body of which is made of sheet steel and sectioned to facilitate installation. The base is of welded steel construction and is provided with gasketed removable access panels and secured in place with screws. It is mounted on a heavy steel support shaft with two bearings; the upper bearing is a throat type roller bearing, and the lower bearing is a heavy duty radial bearing; grease fittings are provided. Thirty lighting fixtures, spaced on 12-inch centers, equipped with screw type plain aviation green globes, illuminate the wind tee. The lamps normally used are 25-watt, 120-volt or 240-volt, A-19 clear bulb. Each section of the tee is completely wired on the inside. Connections between sections are made with twist lock plugs and receptacles furnished with the assembly. Heavy slip rings with brushes are provided in the base to carry the operating current. The wind tee serves as a continuous day and night indicator of wind direction or landing direction. The wind tee gives the appearance of a single green "T" when viewed at night and a single stroke yellow "T" in the day. See Appendix 2, figure 11. A device for no-wind return, a position indicator, or a remote control mechanism may be added to the basic wind tee if specified in the plans and specifications.

(1) Power Supply. Design the power supply system for the wind tee, as specified under paragraph 9a(2), for rotating beacons.

(2) Control System. Design the control system for the wind tee as specified under paragraph 9a(3) for rotating beacons.

(3) Duct and Conduit System. Design the duct and conduit systems as specified in paragraph 9a(3)(c) for the rotating beacons.

19. MAINTENANCE.

a. Wind Cone.

(1) Relamping. Replace at regular intervals all lamps and clean all glassware reflectors and fixtures.

(2) Fabric Cone. Check the condition of the fabric cone to determine whether it should be replaced.

(3) Lubrication. Check the ball bearings and the rotation of the cone assembly, and if required, grease the ball bearings.

(4) Securing Bolts. Check the assembly base securing bolts for tightness and check to see if the wiring at the hinged area has been frayed.

(5) Grounding System. Check the grounding system to determine if it has maintained the designed resistance to ground of 25 ohms.

(6) Photoelectric Control. Where applicable, check the photoelectric control to determine if it will turn on at a level of 35 footcandles and turn off at 58 footcandles at a north sky orientation.

(7) Paint. Check the condition of the paint of all steel wind cone supports for peeling, bare spots, and rusting to determine if touchup or repainting is necessary.

b. Wind Tees.

(1) Relamping. Replace at regular intervals all lamps and clean all glassware and fixtures.

(2) Securing Bolts. Check the wind tee base securing bolts and spot check other wind tee securing bolts for tightness during the relamping procedures.

(3) Paint. Check the wind tee paint for peeling, bare spots, and rusting to determine if touchup or repainting is necessary.

(4) Lubrication. Because of the relatively low speed of all moving parts in the tee and the intermittent operation, the assembly will require little attention. However, a system of periodic inspection and greasing should be established not less than every six to 12 months, depending on the operating conditions.

(a) Motors. Motors with wool-packed bearings are oiled at the factory and for normal service shall not be reoiled during the first year. Reoil for normal service with 30 to 70 drops of a good light (SAE-20) or medium (SAE-30) mineral lubricating oil. Over-oiling is as undesirable as under-oiling. Motors having ball bearings are packed with grease sufficient for about two years of normal service. At the end of that time, the bearings shall be cleaned thoroughly and repacked about one-third full with a good grade of ball bearing grease.

(b) Gear Reductor. At regular inspection intervals, drain and refill the gear reductor using lubricant recommended by the manufacturer.

(c) Horizontal and Vertical Shaft Bearings. Grease the horizontal and vertical shaft bearings at regular inspection intervals with alemite grease, or equal, using the alemite fittings furnished on the main horizontal and vertical shaft bearings. Use a small amount of grease on the open spur gears and main level gears. Do not over grease.

(5) Slip-rings and Brushes. Both the slip-rings and brushes are extra large capacity. Normally, no trouble should be experienced. An inspection should be made, however, at regular intervals. Replace brushes if worn. Sand slip-rings if pitted. Use sandpaper no coarser than No. 0000.

(6) Clutch-Brake. The clutch-brake shall require no adjustment throughout its life. However, if trouble develops or a loss in torque is noticed, a check shall be made in accordance with the manufacturer's instructions. Since this is a dry friction clutch-brake, oil and grease shall not be allowed on the magnet and armature contact surfaces as decreased torque will result. Any oil or grease that does reach the friction surfaces can easily be removed by cleaning with a solvent specified by the manufacturer. Do not drench the friction material. Grooves on the magnet or armature surfaces, after a period of operation, is normal wear. Do not machine either the armature or magnet contact surfaces to remove these grooves. Replace worn clutch brushes with those recommended by the manufacturer.

20. TESTING AND INSPECTION. The instructions in paragraph 12, should be followed for testing and inspecting wind cone and wind tee operation.

SECTION 5. OBSTRUCTION LIGHTS

21. LOCATION. Advisory Circular 70/7460-1 contains the criteria for locating obstruction lights.

a. Selection Consideration. Use the single obstruction light at all locations unless the double obstruction light can be justified due to special siting conditions.

b. Obstruction Light Installation. Obstruction lights are installed on all obstructions which present a hazard to air commerce. They warn airmen of the presence of an obstruction during hours of darkness and during periods of limited daytime visibility. An obstruction's height, size, shape, and the area in which it is located determines the position of lights on the obstruction and the number of lights required to adequately light the obstruction to assure visibility of such lighting from an aircraft at any angle of approach. Standards for determining obstructions to air commerce are contained in FAR Part 77.

c. Power Supply. Design the power supply system for obstruction lights as specified under paragraph 9a(2) for the airport rotating beacon and as specified under paragraph 9b(1) for the hazard beacon.

d. Control System. Design the control system for obstruction lights as specified under paragraph 9a(3) for the airport rotating beacon and as specified under paragraph 9b(2) for the hazard beacon.

e. Duct and Conduit System. Design the duct and conduit systems for the obstruction light as specified in paragraph 9a(3)(c) for the rotating beacon.

22. INSTALLATION.

a. Placing the Obstruction Lights. Install single or double obstruction lights as specified in the proposal and shown on the plans. Mount the obstruction light on poles, buildings, or towers approximately at the location shown in the plans. The exact location shall be as directed by the engineer.

b. Installation on Poles. Where obstruction lights are to be mounted on poles, install each obstruction light with its hub at least as high as the top of the pole. Run all wiring in not less than one-inch galvanized rigid conduit. If pole steps are specified, install the lowest step 5-feet above ground level. Install steps alternately on diameterically opposite sides of the pole to give a rise of 18-inches for each step. Fasten conduit to the pole with galvanized steel pipe straps secured by galvanized lag screws. Paint the poles as shown on the plans and specifications. When obstruction lights are installed on existing telephone or power poles, install a large fiber insulating sleeve of adequate diameter and not less than 4-feet long so that it will extend 6-inches above the conductors on the upper crossarm and at least 18-inches below the conductors on the bottom crossarm in accordance with the plans.

c. Installation on Beacon Towers. Where obstruction lights are installed on beacon towers, mount two obstruction lights on top of the tower using one-inch conduit. Screw the conduit directly into the obstruction light fixtures to support them at a height of not less than 4-inches above the top of the rotating beacon. If obstruction lights are specified at lower levels, install not less than 1/2-inch galvanized rigid steel conduit with standard conduit fittings for mounting the fixtures. Mount all fixtures in an upright position in all cases. Fasten the conduit to the tower members with "wraplock" straps, clamps, or approved fasteners spaced approximately 5-feet apart. Apply three coats of Aviation Orange paint (one prime, one body, and one finish coat) to all exposed material installed under this item except obstruction light globes.

d. Installation on Buildings, Towers, Smokestacks, etc. Where obstruction lights are to be installed on buildings or similar structures, install as shown on the plans. Mount the hub of the obstruction light not less than 1-foot above the highest point of the obstruction, except in the case of smokestacks, mount the uppermost units not less than 5-feet nor more than 10-feet below the top of the stack. Fasten the conduit supports to wooden structures with galvanized steel pipe straps secured by 1-1/2-inch No. 10 galvanized wood screws. Fasten conduit to masonry structures by the use of expansion shields, screw anchors, or toggle bolts using No. 10, or larger, galvanized wood or machine screws. Fasten conduit to structural steel with straps held with not less than No. 10 roundhead machine screws in drilled and tapped holes. Locate the fastenings approximately 5-feet apart. Apply three coats of Aviation Orange paint (one prime, one body, and one finish coat) to all exposed material installed under this item, except obstruction light globes.

e. Series Insulating Transformers. The L-810 obstruction light does not include a film cutout; therefore, an insulating transformer is required with each series lamp. Double series units of this type require two series insulating transformers. The transformer may be housed in a base or may be buried directly in the earth, as shown on the plans.

f. Wiring. Make complete electrical connections from the underground cable or other source of power in accordance with the wiring diagram furnished with the project plans. If underground cable is required for the power feed, and if duct is required under paved areas, install the duct and cable in accordance with Items L-108 and L-110. Install overhead line wire from pole to pole, where specified, conforming to Federal Specification J-C-145.

g. Lamps. Install one or two lamps, as required, conforming to the equipment in Section 1, paragraph 6ee(4).

23. MAINTENANCE. Obstruction lighting shall be visually observed at least once each 24 hours, or checked by observing an automatic, and properly maintained, indicator designed to register any failure of such lights. If the obstruction lighting is not readily accessible for the above visual observation at least once each 24-hours, an automatic alarm system may be installed. The side, or intermediate obstruction lights, may be excluded from the alarm circuit, provided the signaling device will indicate malfunctioning of all flashing and rotating beacons and all top lights regardless of their positions on the obstruction and that all other obstruction lights mounted on the obstruction are visually inspected once every two weeks.

    a. Relamping. Replace all the obstruction lamps at regular intervals after they have been in operation for 75 percent of their normal life.

    b. Rated Lamp Voltage. Check the lamp voltage at the lamp socket to assure that the rated lamp voltage corresponds to (or is within 3 percent higher than) the average voltage across the lamp during the normal hours of operation and provides satisfactory output. Clean all lenses, reflectors, and clean out the fixtures.

    c. Booster Transformer. Check the input and output voltages to determine that the transformer is furnishing the correct rated lamp voltage to the obstruction light sockets during each relamping procedure.

    d. Automatic Control. Obstruction lights installed at an overall height greater than 150-feet above ground, or water if so situated shall be controlled by a light sensitive device, or shall operate continuously. Check each light sensitive control device to assure that it will turn on at about 35 footcandles and turn off at about 58 footcandles, when oriented toward a north sky light intensity. Under normal conditions, either a light sensitive control device or an automatic time control switch may be used to control the obstruction lighting.

    e. Load Contactor. Check the operation of the contactor and inspect the contacts to determine that they are not dirty or pitted. Clean out the unit.

24. TESTING AND INSPECTION. Test and check the components of the obstruction light installation as specified by applicable paragraphs under paragraph 12 for the rotating beacons. If the obstruction lights are installed in a series circuit, check the insulating transformers to determine that each obstruction light is connected to the proper rated transformer.

APPENDIX 1, BIBLIOGRAPHY

1. Obtain copies of the following publications from the Department of Transportation, Distribution Unit, TAD-484.3, Washington, D.C. 20590.

   a. AC 150/5340-5, Segmented Circle Airport Marker System.

   b. AC 150/5345-1B, Airport 51-Foot Tubular Beacon Tower.

   c. AC 150/5345-2 Specification for L-810 Obstruction Light.

   d. AC 150/5345-3A, Specification for L-821 Airport Lighting Panel for Remote Control of Airport Lighting.

   e. AC 150/5345-6, Specification for L-809 Airport Light Base and Transformer Housing.

   f. AC 150/5345-7A, Specification for L-824 Underground Electrical Cables for Airport Lighting Circuits.

   g. AC 150/5345-12A, Specification for L-801 Beacon.

   h. AC 150/5345-13, Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits.

   i. AC 150/5345-18, Specification for L-811 Static Indoor Type Constant Current Regulator Assembly, 4KW; with Brightness Control and Runway Selection for Direct Operation.

   j. AC 150/5345-22, Specification for L-834 Individual Lamp Series-To-Series Type Insulating Transformer for 5000-Volt Series Circuit.

   k. AC 150/5345-26, Specification for L-823 Plug & Receptacle Cable Connectors.

   l. AC 150/5345-27A, Specification for L-807 Eight-Foot and Twelve-Foot Unlighted or Externally Lighted Wind Cone Assemblies.

   m. AC 150/5345-36, Specification for L-808 Lighted Wind Tee.

   n. AC 170/6850-1, Aeronautical Beacons and True Lights.

   o. CAA-291, Specification for Beacons, 36-Inch Rotating, Double Ended Type.

   p. FAA-E-113c, Poles, Wood, Treated.

q. CAA-446, Specification for Code Beacons, Style IV, with red color filters.

2. Obtain copies of the following Federal specifications and standard from the Business Service Centers of General Services Administration Regional Offices.

a. W-P-115, Panel, Power Distribution.

b. WW-C-581, Conduit, Metal, Rigid; Coupling, Elbow; Nipple, Electrical Conduit, Zinc-Coated.

c. J-C-30, Cable and Wire, Electrical (Power, Fixed Installation).

d. J-C-145, Cable, Power, Electrical and Wire, Electrical (Weather-Resistant).

e. TT-P-102, Paint, Oil: Titanium-Lead-Zinc and Oil, Exterior, Ready-Mixed, White and Light Tints.

f. TT-P-59, Paint, Ready-Mixed, International Orange.

g. TT-P-641, Primer Paint, Zinc Dust-Zinc Oxide.

h. TT-R-191, Red Lead, Dry and Paste-In Oil.

i. TT-L-215, Linseed Oil, Raw (for use in Organic Coatings).

j. TT-D-615, Drier, Paint Liquid.

k. TT-T-801, Turpentine, Gum Spirits, Steam Distilled, Sulphate Wood, and Destructively Distilled.

l. Federal Standard No. 595, Colors.

3. Obtain the following military specifications from Commanding Officer, Navy Supply Depot, 5901 Tabor Avenue, Philadelphia, Pennsylvania 19120. Attention: Code CDS.

a. MIL-T-8625a, Anodic Coating for Aluminum and Aluminum Alloys.

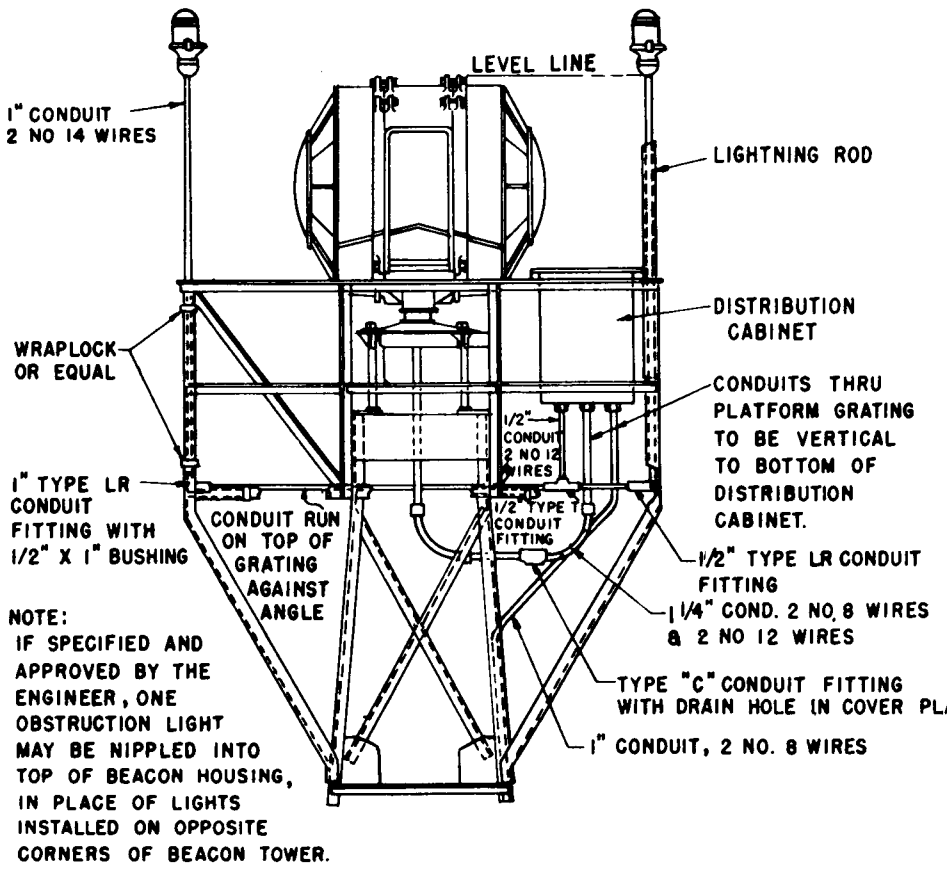
b. MIL-T-8637, Tower and Extension, Aerial Navigation Beacon.

4. Obtain copies of the following FAA advisory circulars and Federal Aviation Regulation, Volume XI, from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Send a check or money order with your request made payable to the Superintendent of Documents in the amount specified below for each copy. No. c.o.d. orders are accepted.

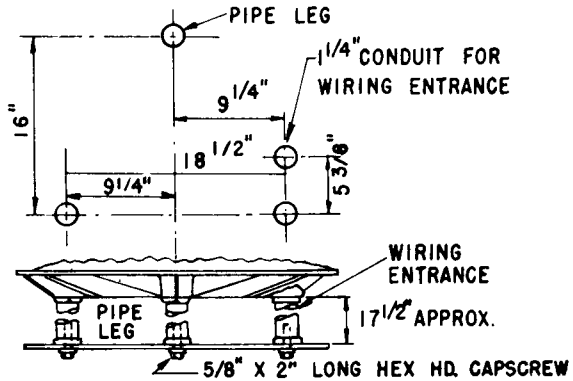
   a. AC 150/5370-1A, Standard Specifications for Construction of Airports. Price for each copy is $3.50.

   b. AC 70-7460-1, Obstruction Marking and Lighting. Price for each copy is $.60

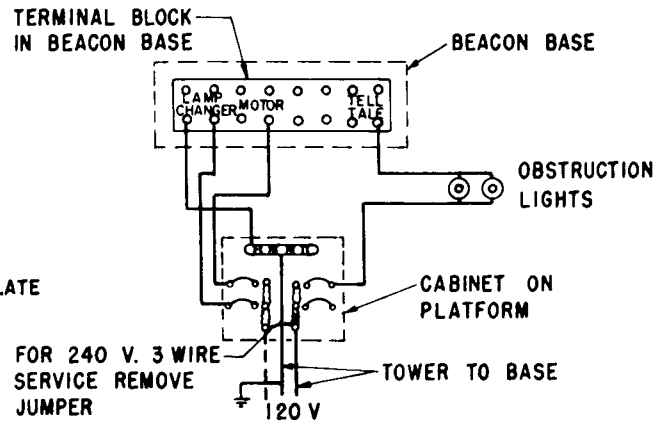
   c. Federal Aviation Regulation, Volume XI, Part 77, Objects Affecting Navigable Airspace. Price for each copy is $2.75.



(a) BEACON MOUNTED ON TOWER PLATFORM



(b) BEACON BASE MOUNTING DIMENSIONS

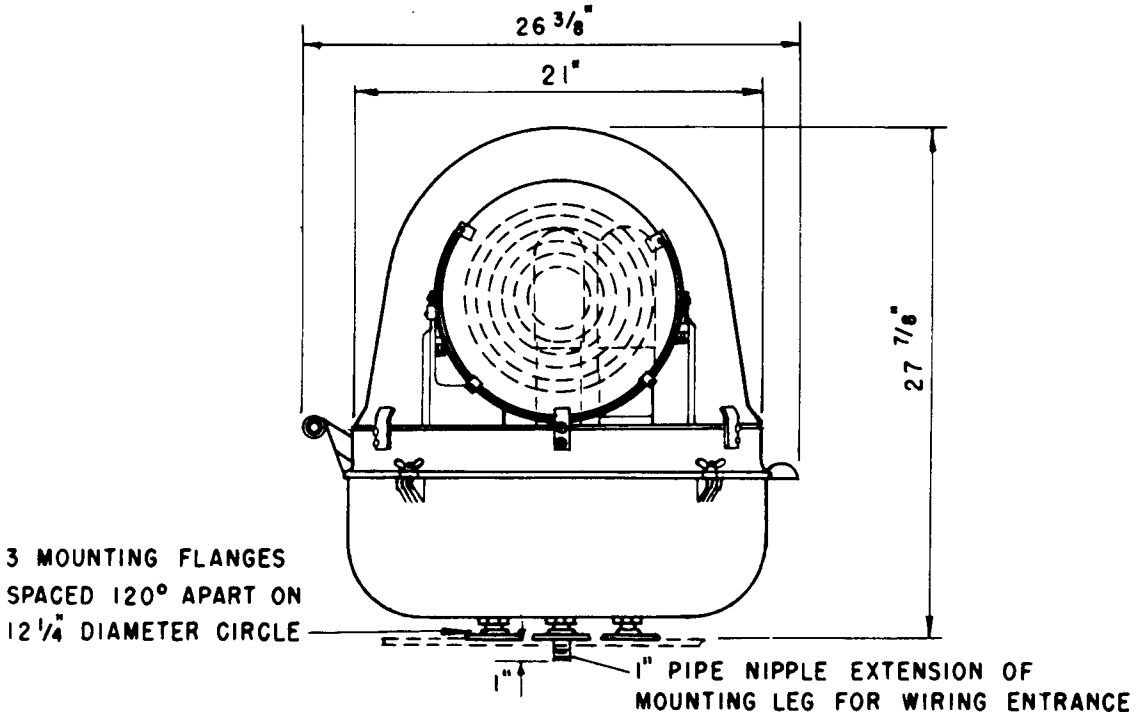


NOTE:
DIAGRAM IS ONLY FOR BEACONS EQUIPPED WITH TELL-TALE RELAY

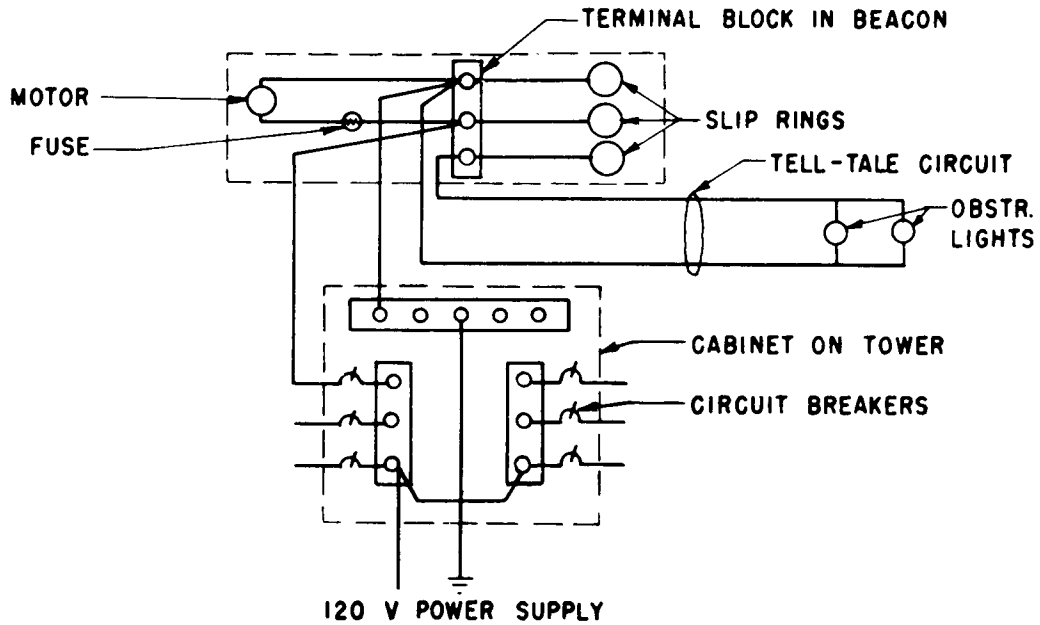
(c) BEACON WITH OBSTRUCTION LIGHTS

WHERE OBSTRUCTION LIGHTS BURN AFTER FAILURE OF NORMAL LAMP

FIGURE 1. 36-INCH ROTATING BEACON

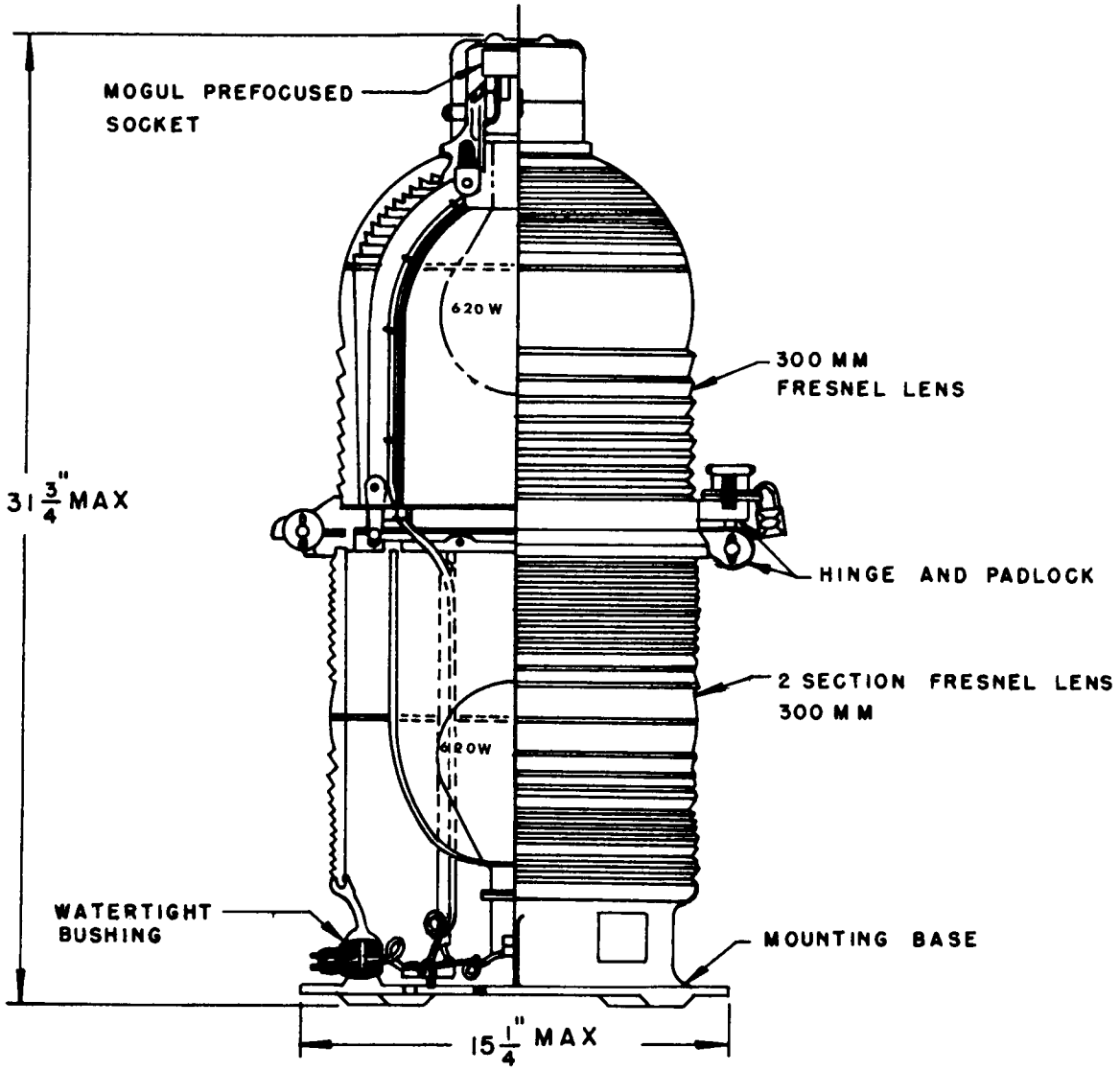


(a) BEACON AND MOUNTING DIMENSIONS

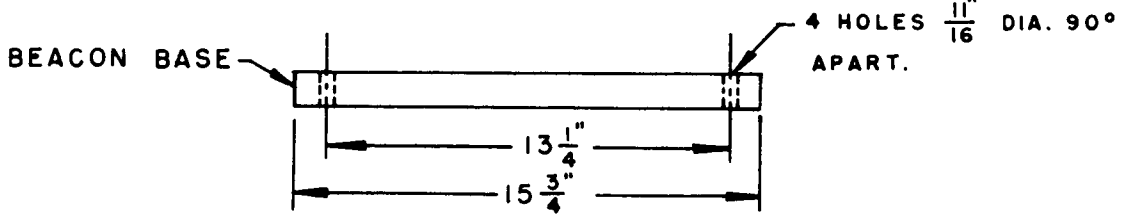


(b) BEACON WITH OBSTRUCTION LIGHTS IN TELL-TALE CIRCUIT

FIGURE 2. 10-INCH ROTATING BEACON

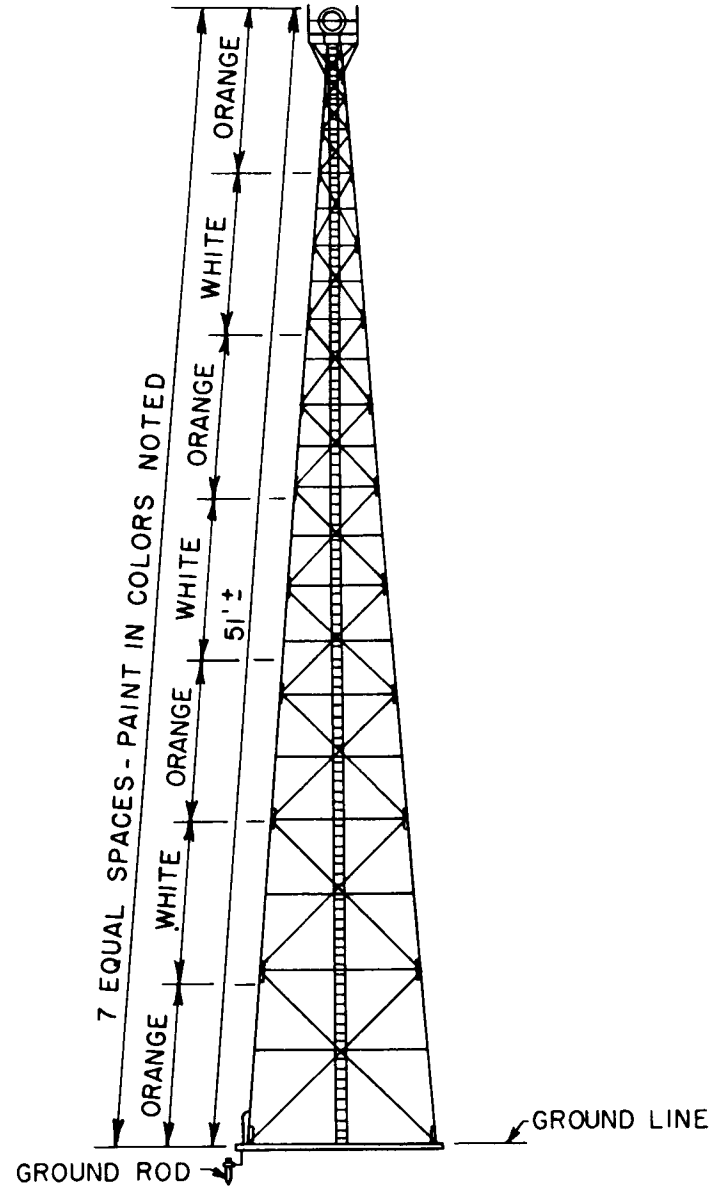


(a) HAZARD BEACON DIMENSIONS



(b) BEACON MOUNTING DIMENSIONS

FIGURE 3. HAZARD BEACON (FLASHING RED)



(a) BEACON TOWER COLOR SCHEME

FIGURE 4. STRUCTURAL STEEL BEACON TOWER AND COLOR SCHEME

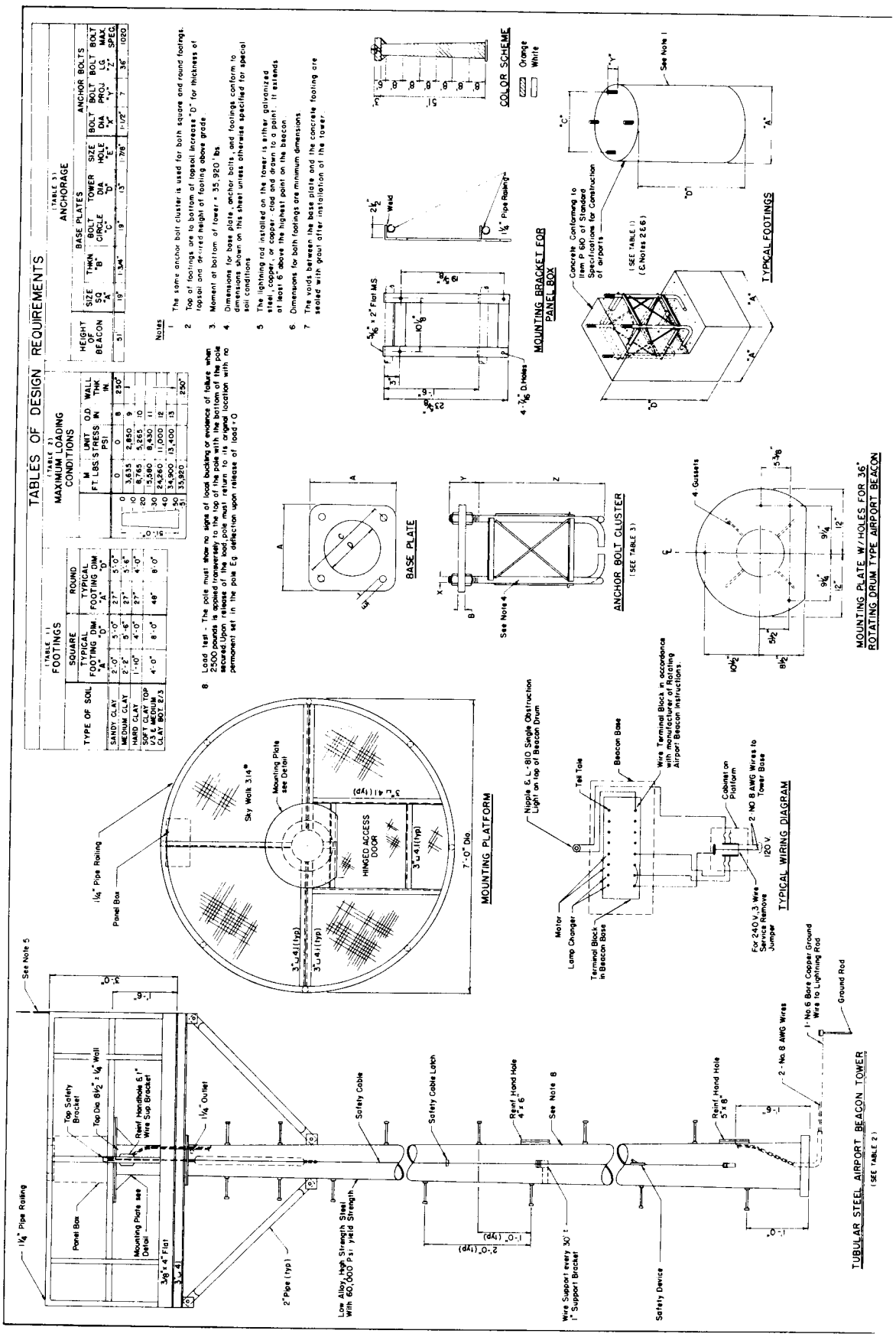


FIGURE 5. TUBULAR STEEL BEACON TOWER

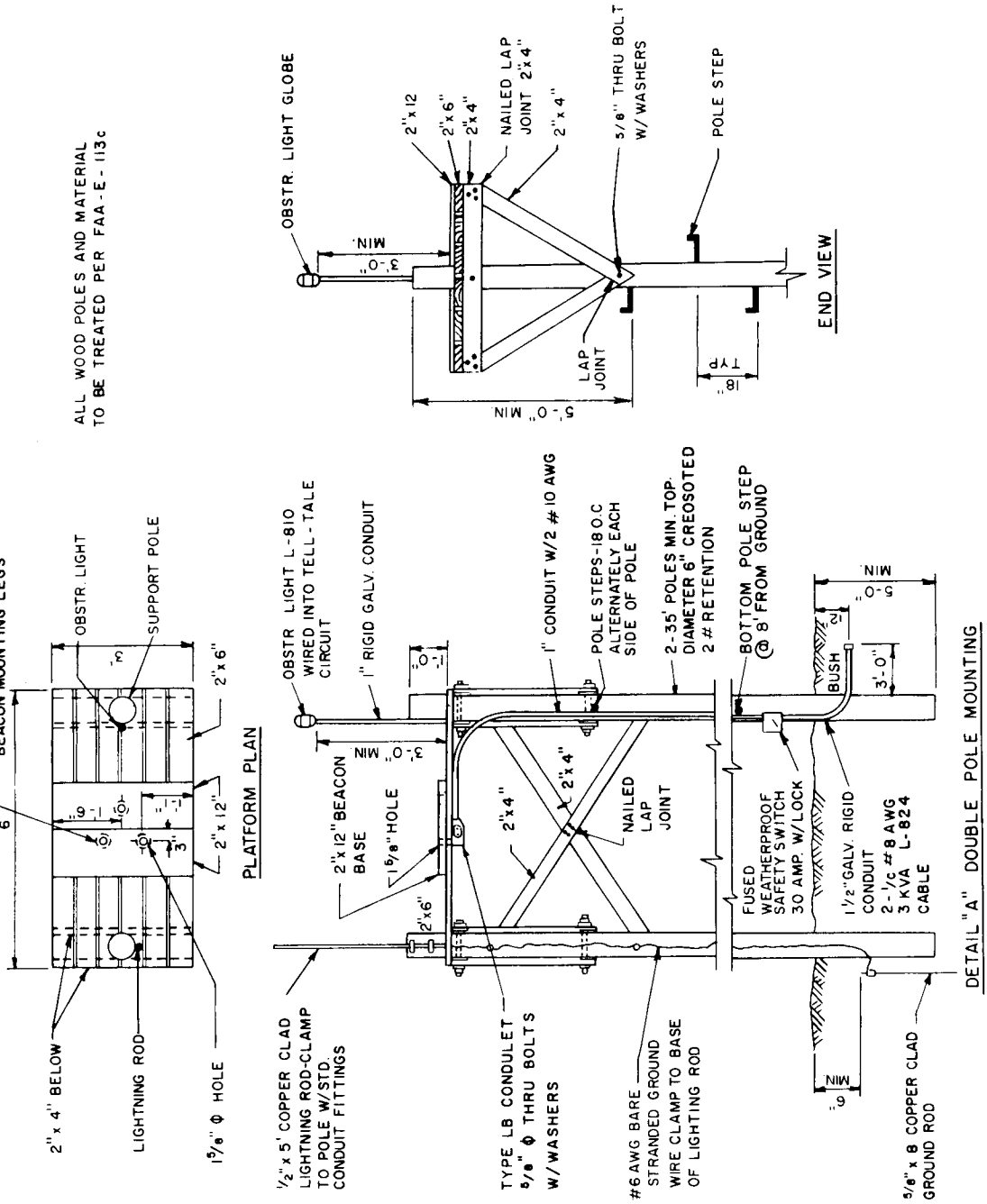


FIGURE 6. DOUBLE WOODEN POLE BEACON TOWER

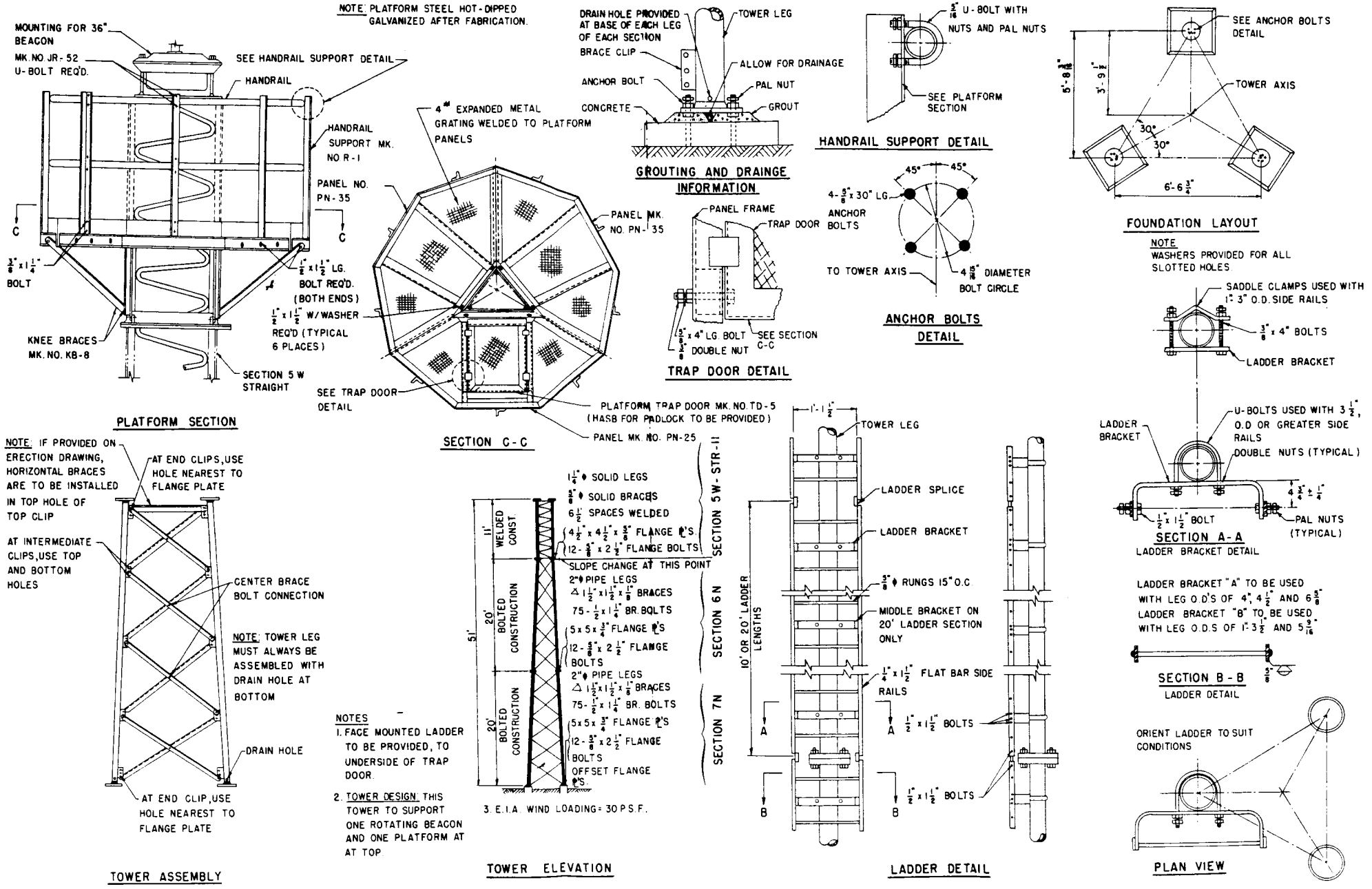


FIGURE 7. PREFABRICATED BEACON TOWER STRUCTURE

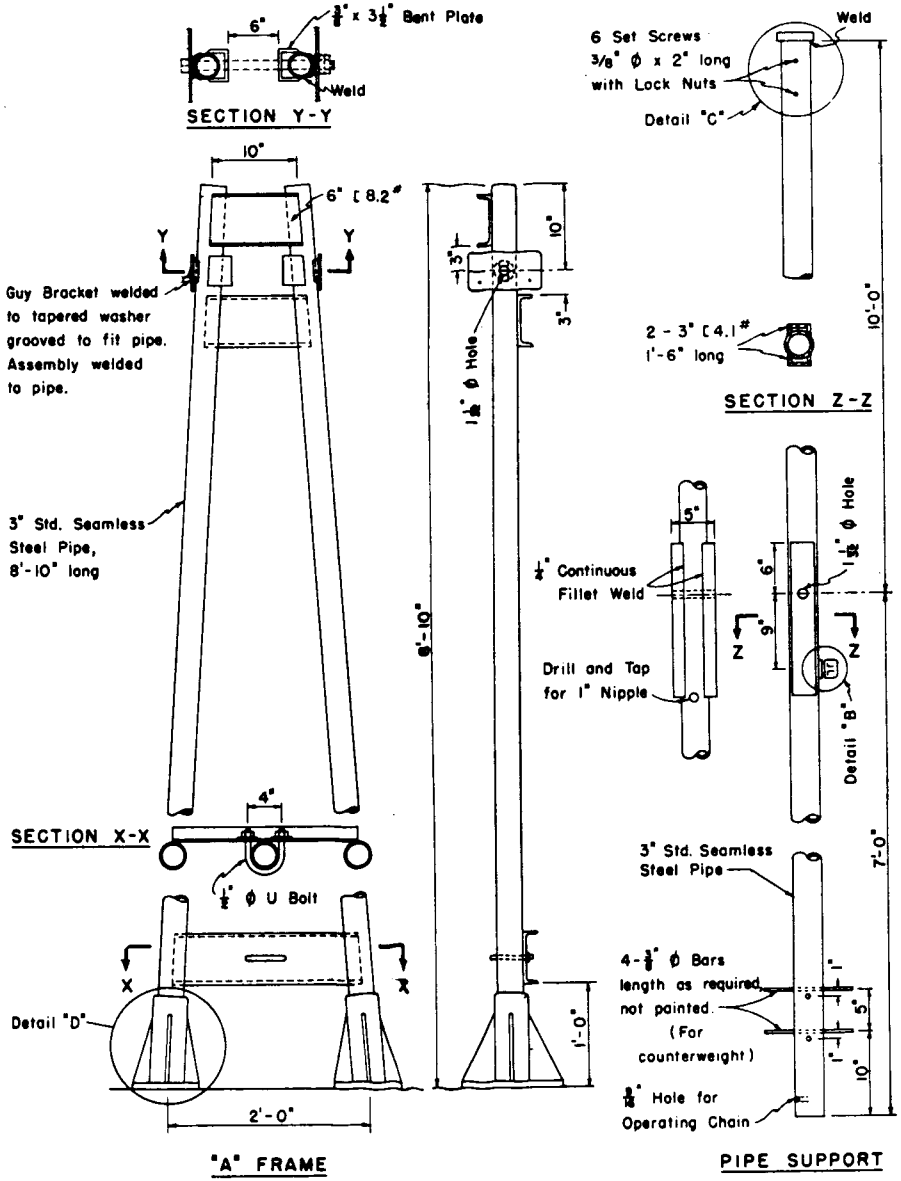
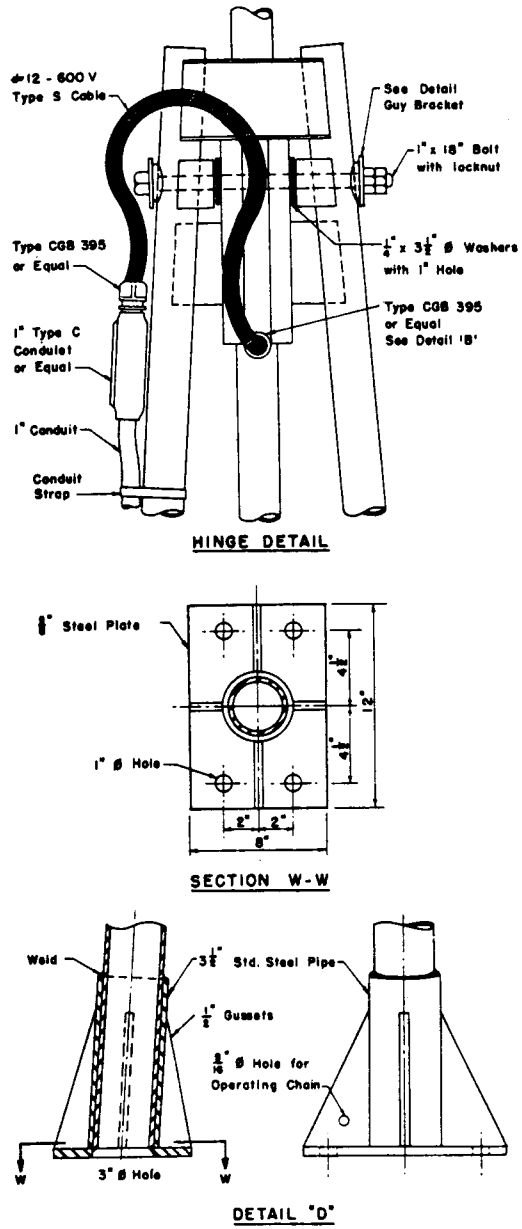
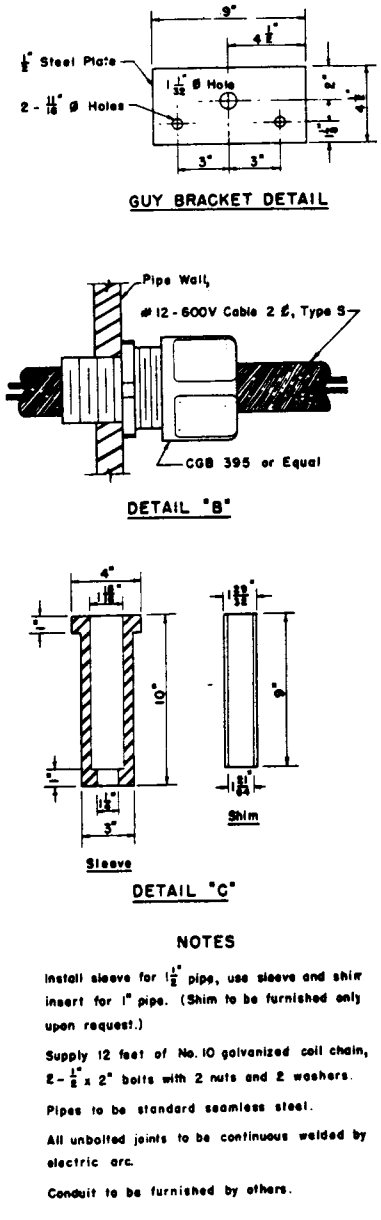


FIGURE 8. "A" FRAME WIND CONE ASSEMBLY





NOTES

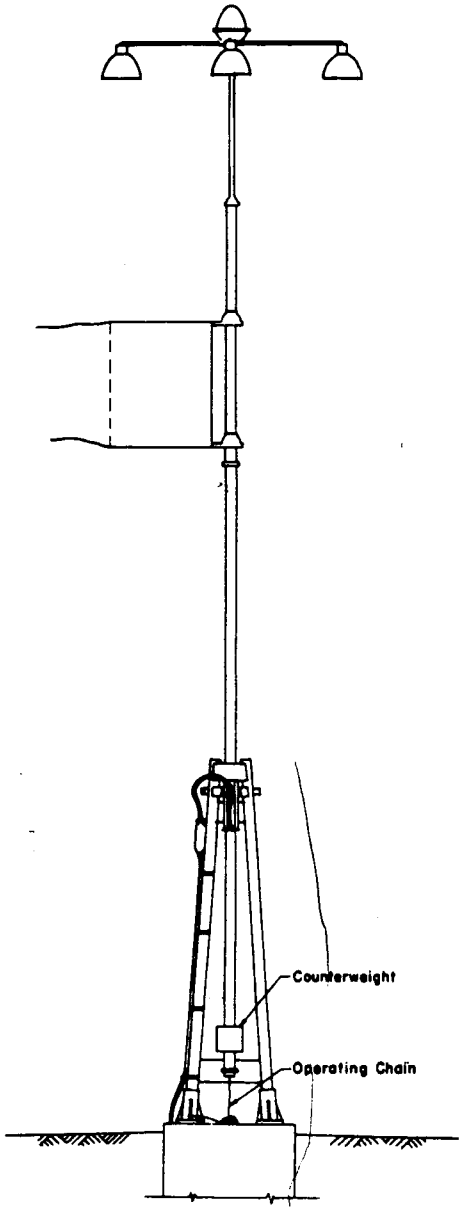
Install sleeve for 1 1/2" pipe, use sleeve and shim insert for 1" pipe. (Shim to be furnished only upon request.)

Supply 12 feet of No. 10 galvanized coil chain, 2 - 1/2" x 2" bolts with 2 nuts and 2 washers.

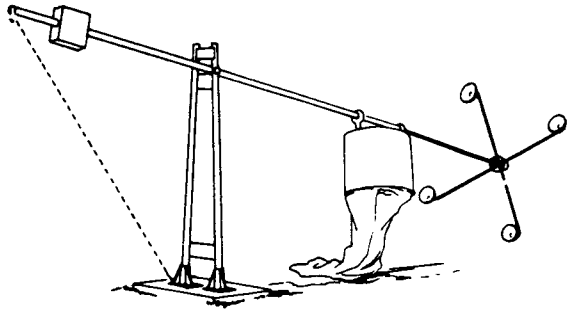
Pipes to be standard seamless steel.

All unbolted joints to be continuous welded by electric arc.

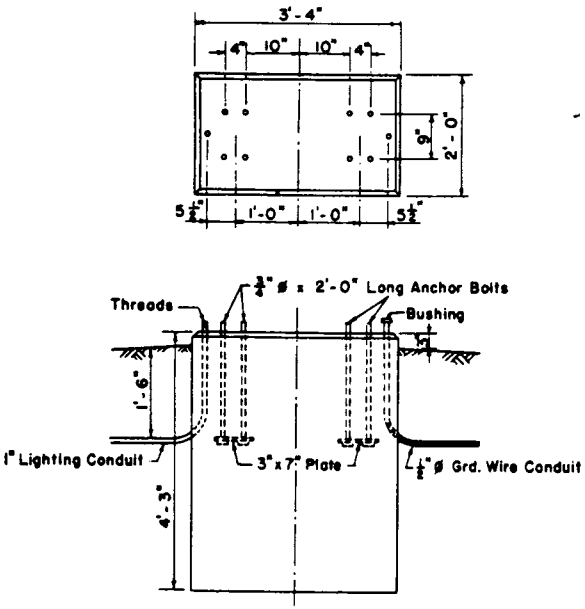
Conduit to be furnished by others.



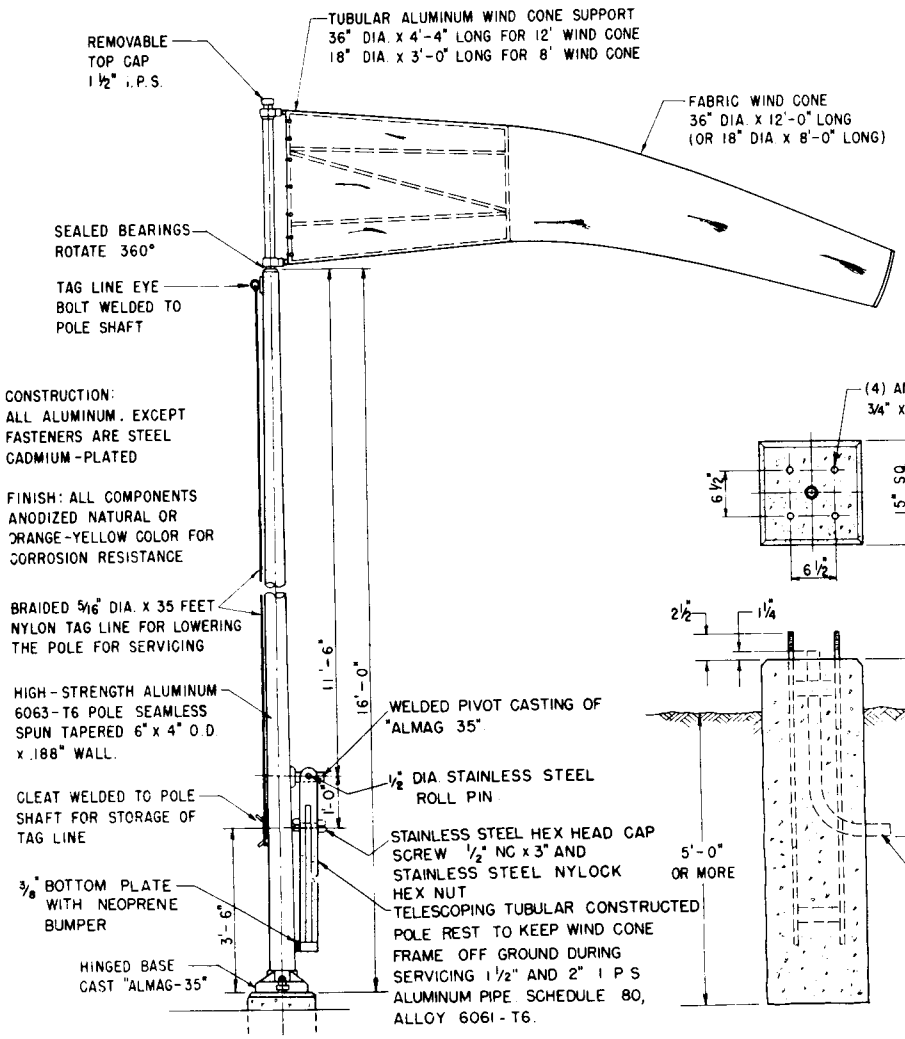
UNGUYED GROUND INSTALLATION



POSITION FOR SERVICING

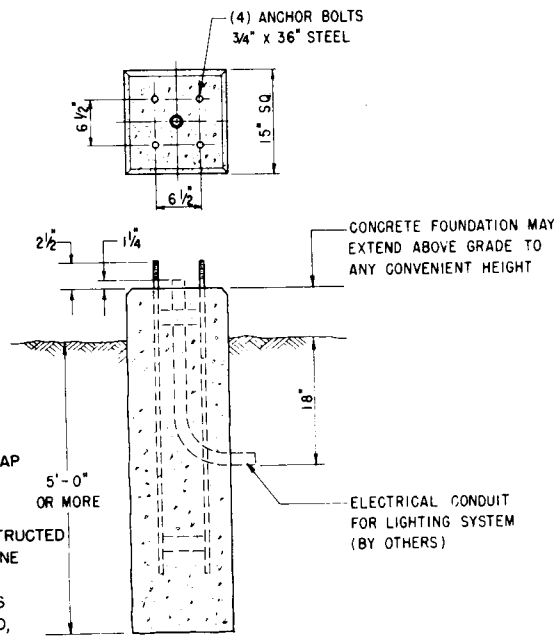


RECOMMENDED
FOOTING DETAIL



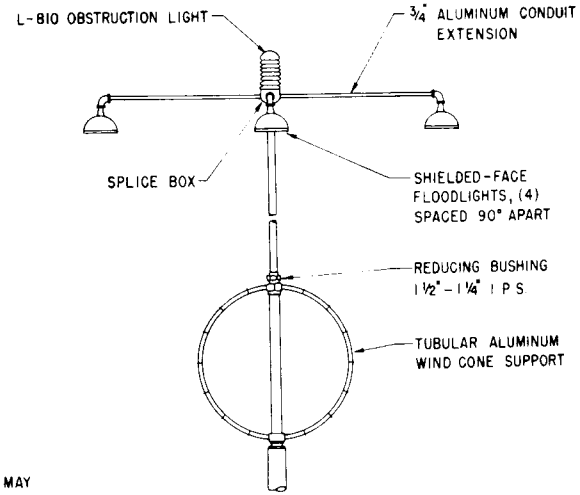
ELEVATION

SCALE: 3/4" = 1'-0"

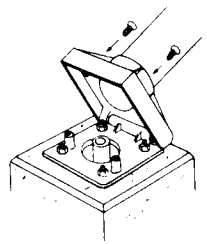


FOUNDATION DETAIL

SCALE: 1/10 INCH = 1 INCH



WIND CONE ASSEMBLY & LIGHTING ASSEMBLY



PATENTED HINGED BASE FOR SERVICING FROM THE GROUND

FIGURE 9. ANODIZED ALUMINUM WIND CONE ASSEMBLY

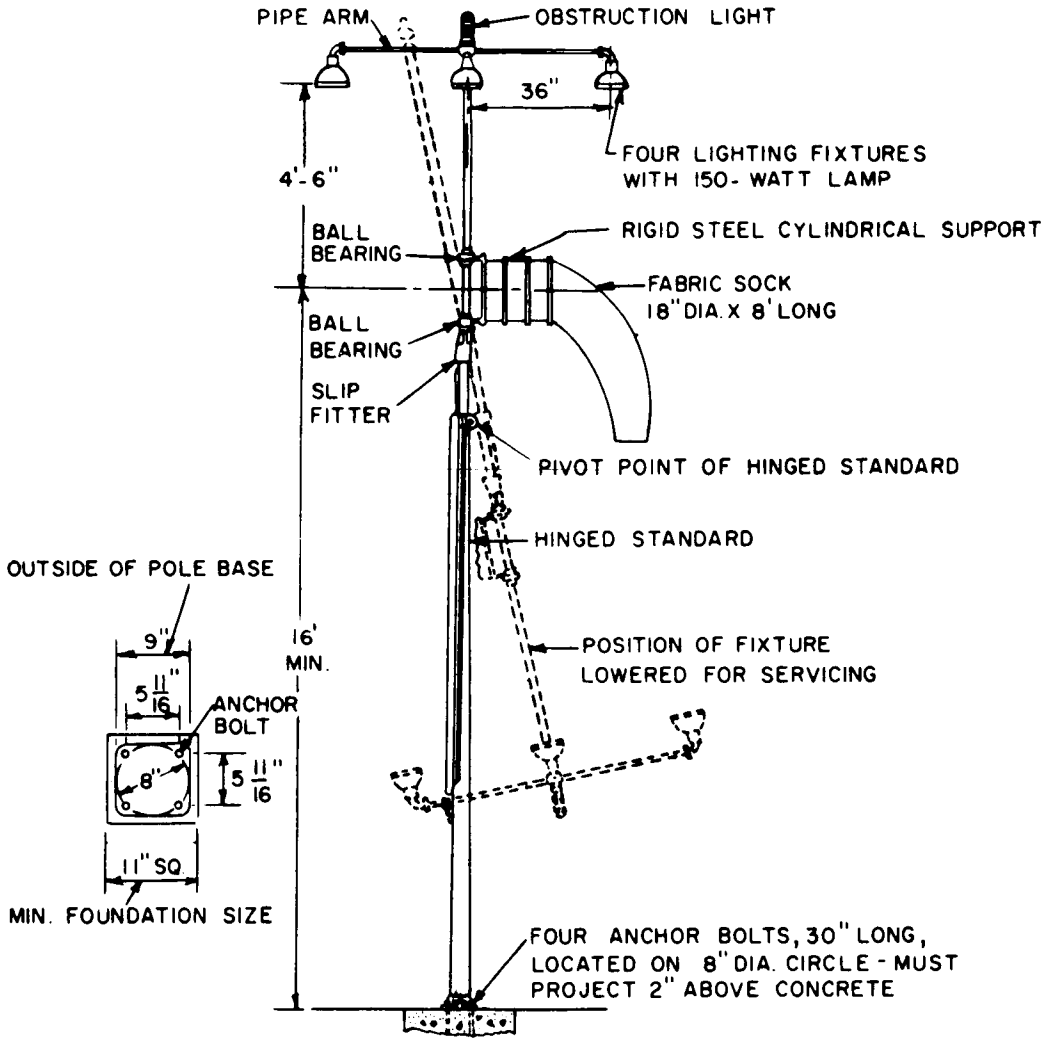


FIGURE 10. TYPE I, EIGHT-FOOT WIND CONE ASSEMBLY

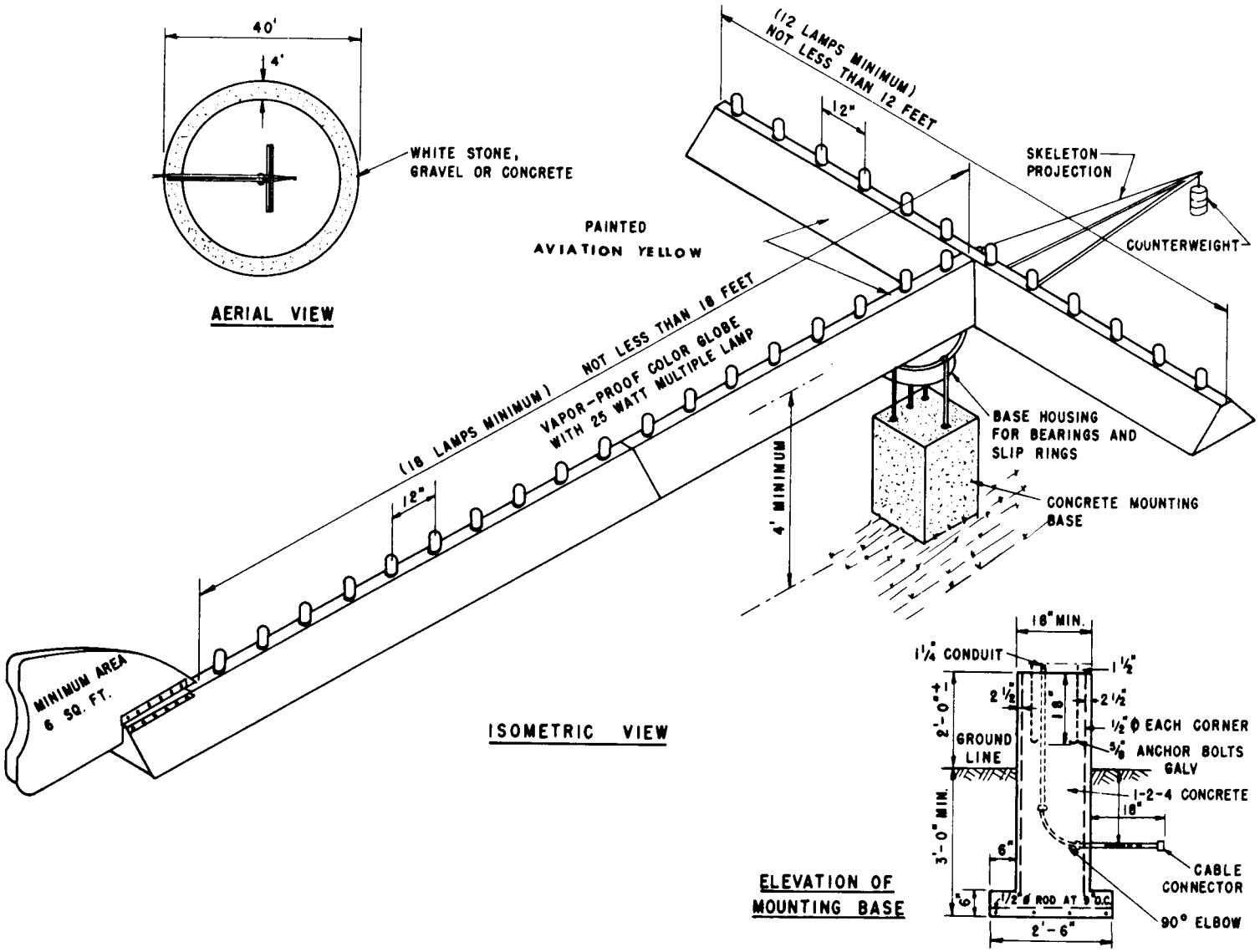
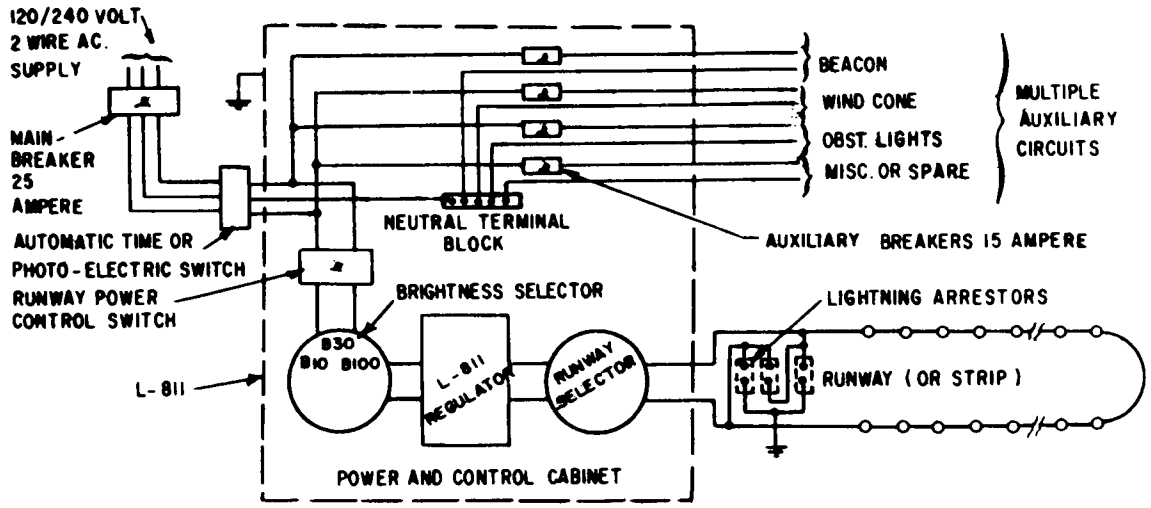


FIGURE 11. WIND TEE



WIRING DIAGRAM FOR SUPPLY REGULATOR

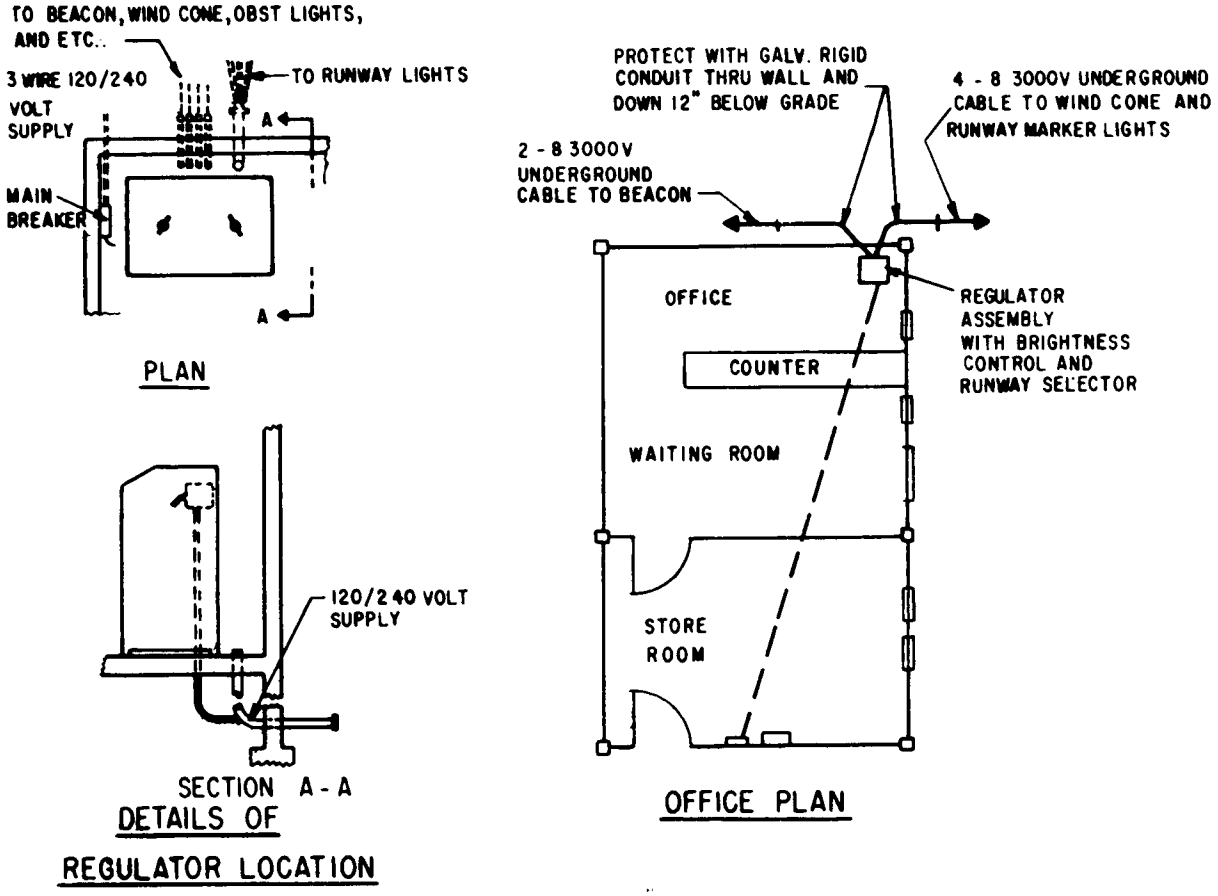
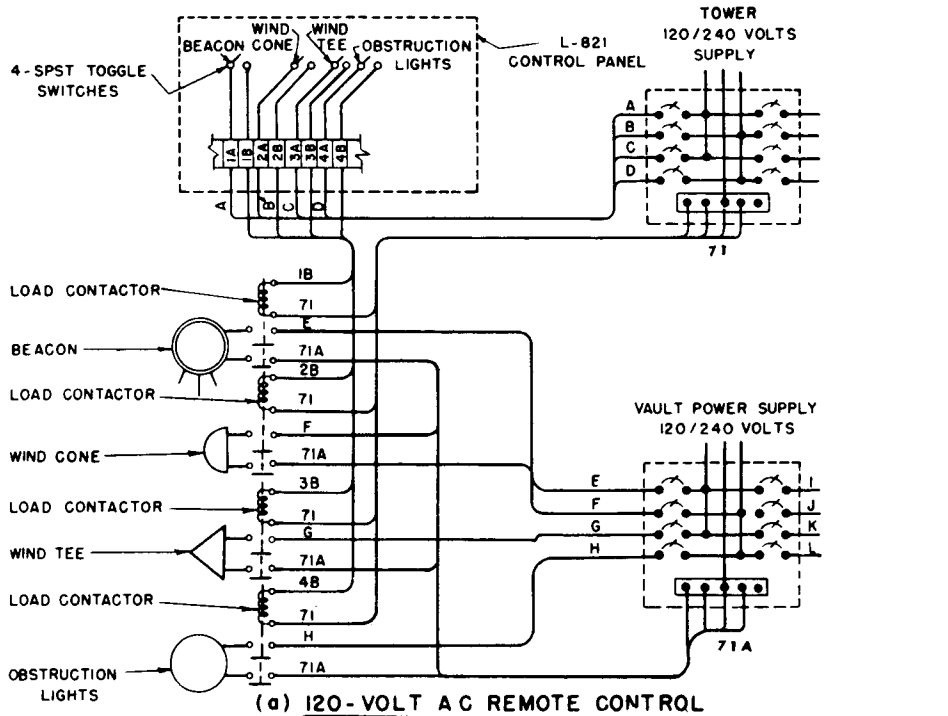
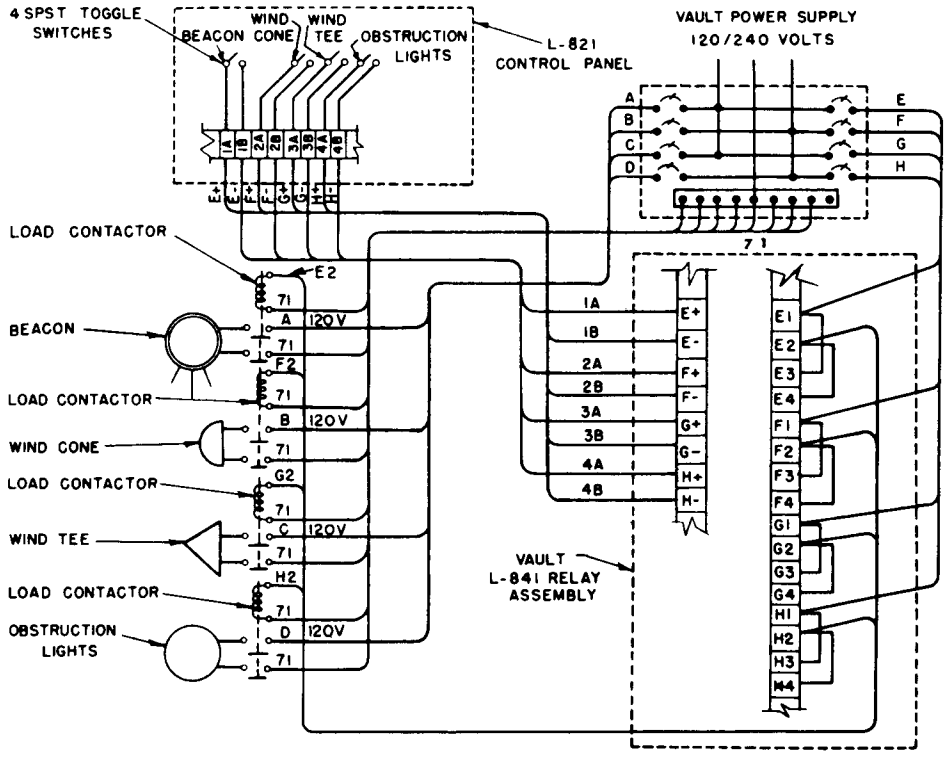


FIGURE 12. L-811 REGULATOR CONTROL



(a) 120-VOLT AC REMOTE CONTROL



(b) 48-VOLT DC REMOTE CONTROL

FIGURE 13. 120-VOLT AC AND 48-VOLT DC REMOTE CONTROL

COPPER-WIRE, AMERICAN WIRE GAUGE (B&S)

B&S GAUGE NO.	OHMS PER 1,000 FEET 25°C., 77°F.	AREA CIRCULAR MILS	DIAMETER IN MILS AT 20°C.	APPROXIMATE POUNDS PER 1,000 FEET
2	0.1593	66,370	257.6	201
4	0.2523	41,740	204.3	126
6	0.4028	26,250	162.0	79
8	0.6405	16,510	128.5	50
10	1.018	10,380	101.9	31
12	1.619	6,530	80.81	20

Calculations

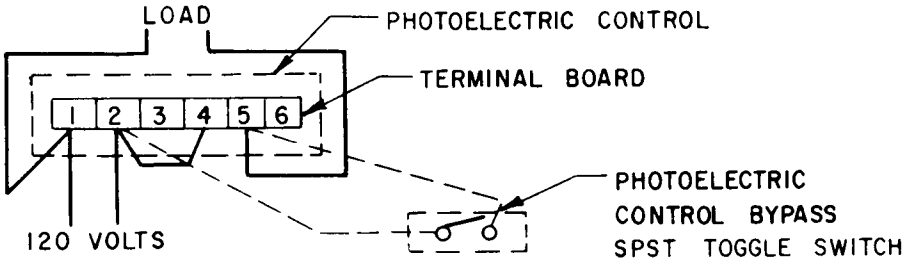
1. To determine the AWG size wire necessary for a specific connected load to maintain the proper voltage for each miscellaneous lighting visual aid, use the above table and Ohms Law $I=\frac{E}{R}$ as follows:

   a. Example. What size wire will be necessary in a circuit of 120 volts AC to maintain a 2 percent voltage drop with the following connected load which is separated 500 feet from the power supply?

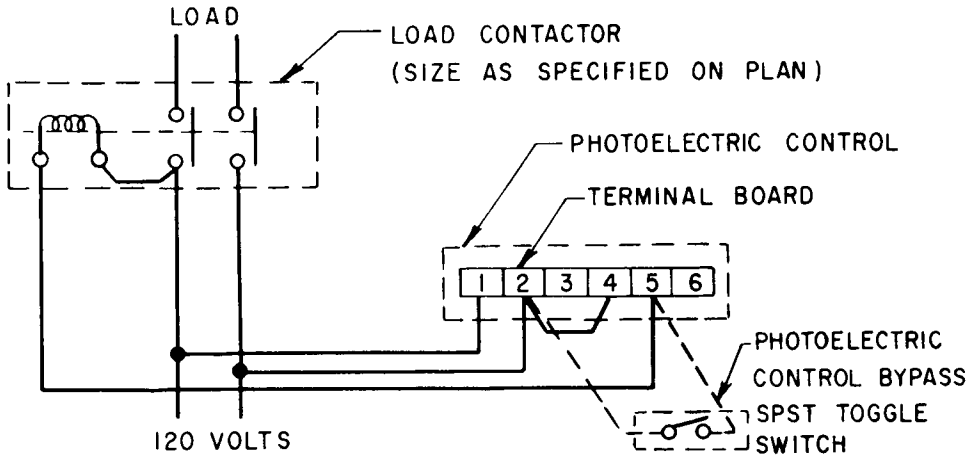
      (1) Lighted Wind Tee Load - 30 lamps, 25 watts each = 750 watts.
      (2) The total operating current for the wind tee is $I=\frac{\text{watts}}{\text{volts}}=\frac{750}{120}=6.25$ amperes.
      (3) Permissible voltage drop for homerun wire is 120 volts x 2% = 2.4 volts.
      (4) Maximum resistance of homerun wires with a separation of 500 feet (1,000 feet of wire used) to maintain not more than 2.4 volts drop is $R=\frac{E}{I}=\frac{2.4 \text{ volts}}{6.25 \text{ amperes}}$ = 0.384 ohms per 1,000 feet of wire.
      (5) From the above table, obtain the wire size having a resistance per 1,000 feet of wire that does not exceed 0.384 ohms per 1,000 feet of wire. The wire size that meets this requirement is No. 4 AWG wire with a resistance of 0.2523 ohms per 1,000 feet of wire.
      (6) By using No. 4 AWG wire in this circuit, the voltage drop is E=IR=6.25 amperes x 0.2523 ohms=1.58 volts which is less than the permissible voltage drop of 2.4 volts.

2. Where it has been determined that it will require an extra large size wire for homeruns to compensate for voltage drop in a 120-volt power supply, one of the following methods should be considered.
   a. A 120/240-volt power supply.
   b. A booster transformer, in either a 120-volt or 120/240-volt power supply, if it has been determined its use will be more economical.

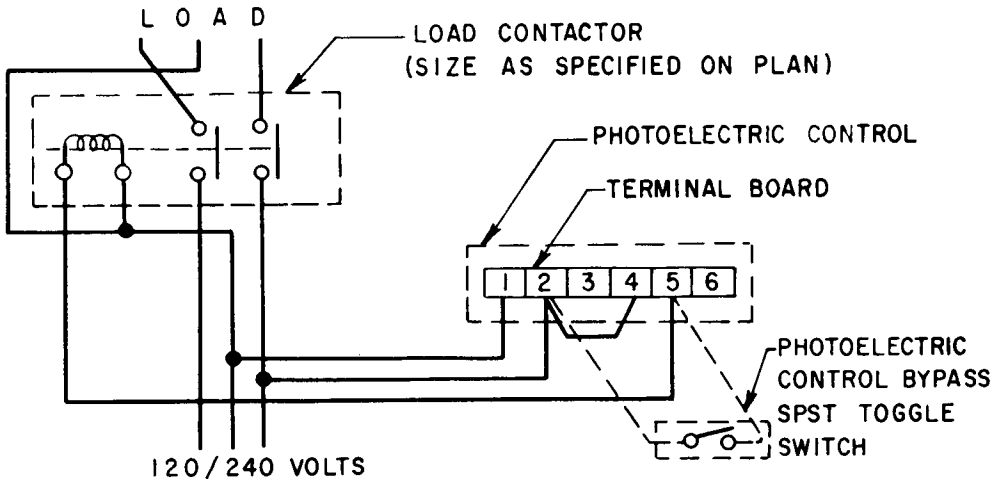
FIGURE 14. CALCULATIONS FOR DETERMINING WIRE SIZE



(a) 120 VOLTS AC, 2 WIRE SERVICE



(b) 120 VOLTS AC, 2 WIRE SERVICE WITH LOAD CONTACTOR



(c) 120/240 VOLTS AC, 3 WIRE SERVICE WITH LOAD CONTACTOR

FIGURE 15. AUTOMATIC CONTROL